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DEPARTMENT OF AGRICULTURE, MADRAS

Bulletin No. 37

BEE-KEEPING IN SOUTH INDIA

BY

S. RAMACHANDRAN, L.AG.
Government Entomologist

WITH AN INTRODUCTION BY

M. C. CHERIAN, B.A., B.SC., D.I.C.
Principal, Agricultural College, Coimbatore

REVISED FOURTH EDITION

PRINTED BY THE SUPERINTENDENT
GOVERNMENT PRESS
MADRAS
1952

Price, 1 rupee

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GOVERNMENT OF MADRAS

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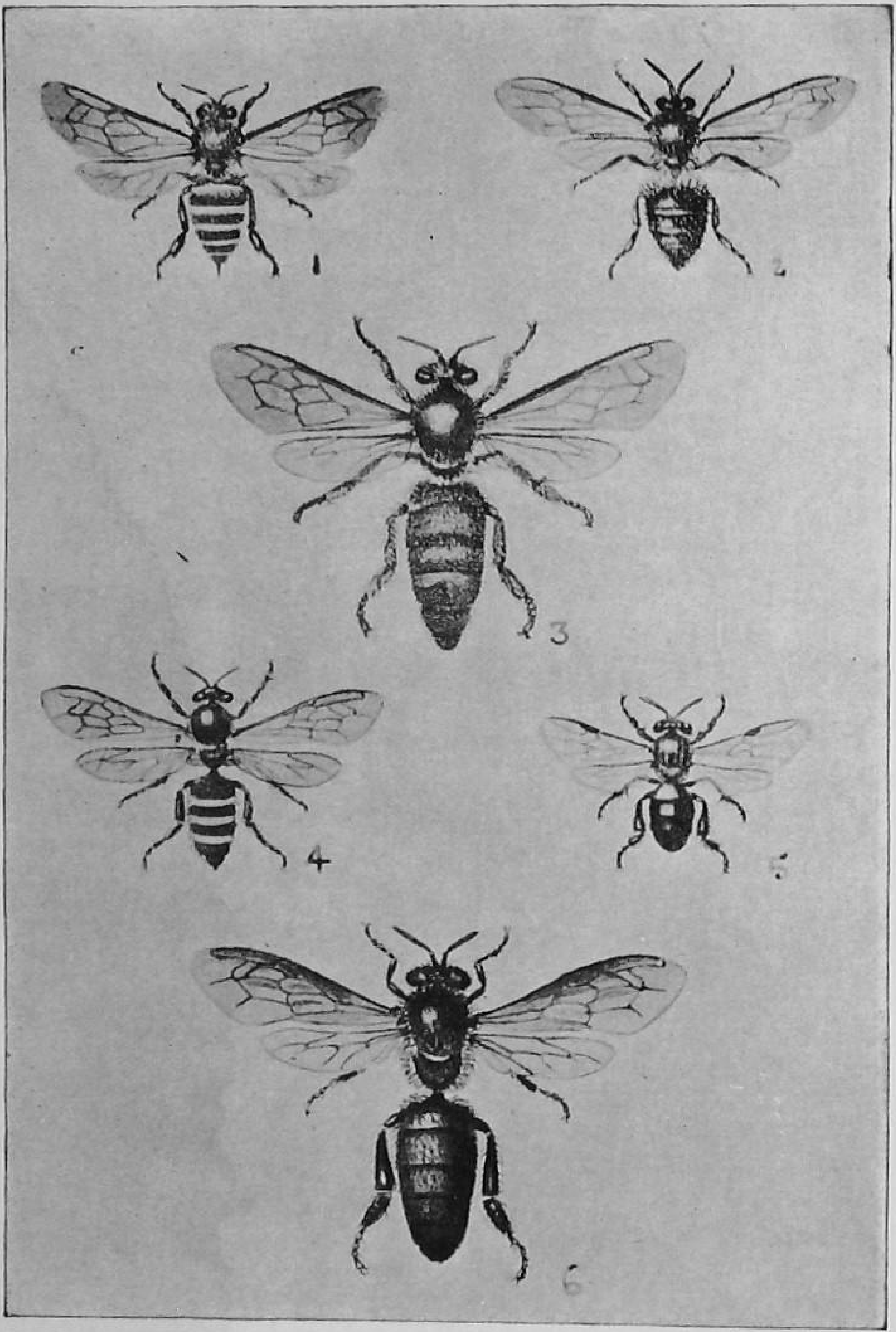

INDIAN HONEY BEES

1. *Apisindica*—worker.
2. *Do.* —drone.
3. *Do.* —queen.
4. *Apis florea*—worker.
5. *Melipona sp.*—worker.
6. *Apis dorsata*—worker.

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INTRODUCTION.

In these days of economic depression, bee-keeping, as a cottage industry, has great possibilities. The appliances needed for the same are not many, nor are they costly. Moreover, bee-pasturage is available in most of the localities of this Presidency. Hence the ryots will be well advised to keep a few hives to enhance their scanty earnings from agriculture.

In this connexion, it has to be admitted, that while in Western countries the Italian or European bee (*Apis mellifica*) has been studied in detail and there is an enormous amount of literature available on this bee, the information on the Indian bee (*Apis indica*), the only one of the indigenous bees which can be domesticated, is very meagre indeed. Popular publications giving practical hints to the amateur bee-keeper are also very few. Mr. S. Ramachandran's bulletin 'Bee-keeping in South India' has, therefore, supplied this long felt need. The author has been in charge of the apiary attached to the Entomological Section for the past five years and has a sound knowledge of bee-culture. His publication contains very useful information on the various aspects of the bee-keeping. I have great pleasure in recommending this invaluable guide to all those who are interested in the subject.

M. C. CHERIAN,
Government Entomologist.

AGRICULTURAL RESEARCH
INSTITUTE, COIMBATORE.
July 1936.

PREFACE TO THE FIRST AND SECOND EDITIONS.

" He is not worthy of the honey-comb
That shuns the hive because the bees have stings."

—SHAKESPEARE.

To the average South Indian ryot, the real story of the honey-bee is a closed book and the insect is often viewed with prejudice chiefly on account of the pain imparted by its sting to the unwary intruder. In some places, the dislike towards these unfortunate creatures has developed into a sort of sentimental objection to such an extent, that the very presence of a colony of bees anywhere within a place of residence is considered inauspicious. If, by any chance, a swarm of bees settles anywhere within the precincts, that in itself is considered to be a pollution and steps are immediately taken to drive it away. It is needless to add here that all these ideas are, after all, purely sentimental, based on superstition. The general knowledge possessed by the layman about the domestic economy of these intelligent insects is practically nothing and the little we find in that direction is a great deal mixed up with wild stories having hardly any scientific foundation, for even to-day there is a belief that the bees drink away the honey stored in the combs just before every New Moon. The only persons who appear to possess some knowledge of bees in India, are the professional bee-hunters in the forests, who go about during certain seasons, mercilessly smoke down colonies, take out the honey-combs very often with the brood and squeeze out as much as the fluid as they can and sell it as honey. It is also probably well-known that the Forest Department generally gets some revenue from what are called ' Minor Forest Products ' of which honey and bees' wax together form a major item. Despite the ignorance displayed about the bees, honey itself has been used from time immemorial in all Indian house-holds either as an important food ingredient or as a vehicle for many of our indigenous medicines. The common use of honey in religious functions as well as for purposes of worship hardly requires any special mention here. For these purposes, it is purchased either from the professionals or from the bazaar; but in both these

cases the liquid can hardly be called honey. Apart from the fact that it is extracted in the crudest and most unhygienic manner, it contains an appreciable quantity of extraneous matter, including the animal juice squeezed from the brood. Very often sugar syrup in which a few combs have been squeezed just to give a flavour, is passed off as honey in the bazaar. Even the purer form of honey bought and stocked from the professional by the petty grocer gets hopelessly fermented by the time it reaches the consumer owing to the contamination and imperfect preservation.

Turning for a moment from the sad picture to what is happening in this direction in the Western countries, we find that not only is honey used largely as a valuable food but that the art of bee-keeping has become established as an organized industry and the production and extraction of bee-products are carried on a very extensive scale employing clean and hygienic methods. It is really deplorable that when bee-keepers in the West are now using engines for honey-extraction and motor lorries for the transport of the produce, the Indian ryot does not as yet possess even a rudimentary knowledge of this fascinating industry.

The income from agriculture is poor in these days and the Indian ryot, under the circumstances, can hardly make both ends meet. The present economic depression has only aggravated matters. The Indian farmer has, therefore, to look to other activities by means of which he can add to his scanty income from the land and Apiculture on improved lines, as a side line to farming, appears to present immense possibilities in this country. There is no dearth of bees or of bee-pasturage in India but in the absence of proper guidance and knowledge on the subject, our ryots do not take advantage of these natural resources and enormous quantities of honey are thus going to waste. Apart from the yield of honey, the importance of bees as agents in cross-pollination of many plants cannot be over-estimated. In the Western countries, a few bee-hives have now become a valuable and necessary adjunct to most of the orchards, more for the pollination by the bees than for their honey and it has been rightly observed that bees indirectly add to the resources of the country more by cross-pollination than by the yield of honey and wax. On the whole, it is felt by the writer that it is high time that our farmers take to bee-keeping as an important side-industry.

At the instance of the Madras Government, an Apiary was started by the Government Entomologist at the Agricultural College, Coimbatore, in 1931. The work has been in progress during these five years and some interesting results have been obtained. The industry has attracted public attention and unmerous enquiries are frequently being received on the technical aspects of the subject. In the absence of any up-to-date departmental publication on this subject, the writer has, at the suggestion of the Government Entomologist, attempted to bring together in this booklet the experiences gathered during this short period, under the conditions round about the Agricultural College with the idea that the publication of the same might bring home to the South Indian villager some of the possibilities of scientific bee-keeping as a cottage industry and give him the necessary hints towards the management of an Apiary.

Though the writer is entirely responsible for the writing up of the matter and for the many inevitable short-comings attending such a venture in a new line, he is indebted to Dr. T. V. Ramakrishna Ayyar, B.A., PH.D., Government Entomologist (retired) and to Mr. M. C. Cherian, B.A., B.SC., D.I.C., Principal, Agricultural College, Coimbatore, for the valuable suggestions and kind help he has been receiving all along in this work. The writer hopes that as the first detailed publication on the subject in South India, the booklet would serve some useful purpose for amateur bee-keepers.

S. RAMACHANDRAN,
Assistant Entomologist.

July 1936.

PREFACE TO THE THIRD EDITION.

The first edition of this bulletin was published during 1935, and the second one during 1937. Both these editions were sold out almost within a year after their publication, which only indicates the rapid popularity the industry is gaining in this Presidency. The third edition is now offered with considerable additional information gathered during these years and with a number of alterations in the matter so as to present a more comprehensive account of the subject.

November 1938. S.R.

PREFACE TO THE FOURTH EDITION.

The third edition was published during the year 1939 and the fourth is presented to the public after a lapse of over twelve years. Research work on bees has been in progress all these years and some interesting results obtained. Gists of these results are incorporated in this edition along with a number of new illustrations. The author also wishes to acknowledge the use of a few published and manuscript records of the work done by his collegues who were in charge of the apiary from time to time. With these improvements, it is hoped that this booklet would serve as an up-to-date and useful guide to amateurs interested in the subject. The present edition was prepared under kind encouragement and facilities provided by Sri T. V. Subramaniam, B.A., Government Entomologist, and the author takes this opportunity to thankfully acknowledge all the help rendered by him.

September 1951. S.R.

BEE-KEEPING IN SOUTH INDIA.

CHAPTER I.

THE HONEY-BEE.

" And well, ye infant wanderers, may ye trace
In each fine fibril of the insect race
The hand of Heaven, which forms with equal care
The tiny tubules of the slenderest hair."

—EVANS.

General facts regarding honey-bees.—Before we enter into the main scheme of bee-keeping it will be advantageous to get some clear ideas regarding the position of the honey-bees in the animal kingdom and some general facts about their anatomy and physiology which should interest a layman bee-keeper. On account of its long and intimate association with man, the term ' bee ' has been popularly understood to refer to the domesticated honey-bee but the name can be applied without mistake to a number of other insects; in fact over four thousand of them are known to come under this category.

Honey-bees belong to the family Apidæ of the order Hymenoptera. Like other bees they have the habit of visiting flowers to collect pollen and nectar. They possess long tongues to reach the nectar in flowers and plumose branched hairs on their bodies to facilitate the adherence of pollen grains. They pass through a complete metamorphosis during their development like beetles and butterflies. The fertilized female lays a number of eggs singly. These hatch into helpless flashy grubs which have to be fed by the other members of the colony until they pupate and emerge as adults.

External anatomy of the honey-bee (worker).—The honey-bee like most other insects, has its body divided into three clearly defined parts, the head, thorax and abdomen, with two constrictions between the three divisions and possesses three pairs of legs. The head (Fig. 1) is movably joined with the thorax by a slender neck. It is widest at the top and gradually tapers below, presenting a flattened triangular appearance. The important organs borne on the head are a pair of antennæ, a pair of compound eyes, three ' ocelli ' and a set of complicated mouth-parts. The antennæ are situated in the middle of the face and are the main organs of smell. They are generally in continuous movement to apprehend the surrounding conditions and are popularly known as ' feelers '. The two corners of the triangular head bear the pair of compound eyes. Each compound eye is made up of a great many separate eye elements, each complete by itself and the external surface

presents the appearance of a honey-comb. These are the main organs of vision. The 'ocelli' or the simple eyes are three minute dots situated on the top of the head and are probably organs of poor vision. At the lower end of the face are situated the highly complex mouth-parts adapted for sucking liquids as well as for biting and tearing hard objects. The whole organ consists of several appendages each having its own specialized function. The upper lip (labrum) is present in the form of a loose flap and on its under-surface is a small soft lobe (epipharynx) bearing the organs of taste. At the sides of the upper lip are the two strong jaw-like structures (mandibles) which are the main organs for biting, tearing and gnawing solid food. They are also used for kneading and moulding particles of wax, etc. Behind the labrum and mandibles is a group of long slender appendages, which together constitute the 'proboscis' and these are generally kept folded beneath the head. These organs correspond to the second pair of jaws or maxillæ and the lower lip or labium of other insects (Fig. 2).

The thorax is the next division carrying the organs of locomotion, which consist of the three pairs of legs (Fig. 3) and two pairs of wings. Each pair of legs in its turn bears some modified structures to perform some special functions besides walking. Each leg consists of five joints, namely, the coxa, trochanter, femur, tibia and tarsus. The last joint "tarsus" is again divided into five smaller joints and is provided with a pair of teriminal claws, with a sticky pad in between, to enable the bee to cling to rough as well as smooth surfaces. The fore-legs are the shortest of the three pairs. They have fringes of short stiff hairs along the anterior edge of the inner surface of the tibia, constituting what is known as the "eye brushes" for cleaning the compound eyes. The tarsus is provided with long unbranched hairs forming a cylindrical "pollen brush" for wiping down the pollen grains which adhere to the body of the bee during the act of pollen-gathering. At the base of the inner margin of the first tarsal joint there is a semi-circular notch, provided with a fringe of comb-like row of bristles, and a large flat spur on the end of the tibia, the whole constituting the "antenna cleaner" so called because of its use for cleaning the antennæ. The middle legs are less specialized than either the fore or hind legs, but the large basal joint of the tarsus is wide and flat and its hairy surface supplements the function of the pollen brushes in the fore-legs. At the distal end of the inner edge of the tibia, a thick sharp spine—the waxpick—is present which is useful for removing the flakes of wax from the wax-pockets on the underside of the abdomen. The hind legs are equally interesting since they also bear some special adaptations. The outer surface of the tibia in each leg is smooth, slightly concave and is fringed on both the edges with long hairs which curve outwards, the whole constituting the "pollen-basket". The pollen which is collected from flowers is packed into these receptacles for transport from the field to the hive. The hairs provided on the tarsus also aid the

collection and pasking of the pollen dust. The wings are primarily meant for quick flight and are, therefore, supported by strong muscles. They are also used for ventilating the hive as explained in a subsequent chapter. The innumerable tiny hairs on the body of the bee help the easy sticking of the pollen grains.

The abdomen.—It consists of ten segments, some of which are not clearly visible. The main organs of interest occurring in this division are the scent glands, wax glands and the sting. The scent glands are situated on the last tergal plate of the abdomen and the odour which is supposed to be particular to each colony is secreted by these glands. The smell emitted is mainly useful for finding out strangers in the colony. Apart from this, foraging bees are said to leave traces of this odour in favourable spots of pasturage to serve as land-marks for their subsequent visits and to attract the other members of the colony to that particular spot.

Wax glands (*Fig.* 4) are present on the lower side of the fifth, sixth and seventh segments of the abdomen. The wax is secreted by these glands as a linquid and it trickles through the wax plates into the pockets between the overlapping parts of the sterna, which serve as moulds for the little flakes of wax when the liquid hardens. These are again moulded by the insect artisans into cells. These glands are said to be active only in young bees. In the case of older bees they get shrunk and do not function.

The sting (*Fig.* 5).—It is situated in a special chamber at the end of the abdomen from which it can be quickly exerted when there is a necessity. The portion that is left behind after the bee stings consists of the dark coloured sting with its appendages, the poison gland, a set of muscles and sometimes a portion of the entrails also. The structure of the sting is somewhat complicated but a simple description of the same is given below. It comprises of a sheath, with its middle portion swollen like a bulb, the distal end tapering like a shaft. Two slender lancets are present at the ventral side of the sheath and each of them is provided with a series of barbs pointing backwards at the tip.

Internal organs.—The honey-bee, just as any other animal, possesses its own highly developed digestive, circulatory, respiratory, nervous and reproductive systems, but a detailed description of these is not attempted here. A word may, however, be said about the presence of what is known as the "honey stomach" in the digestive canal. Bees suck in and hold the nectar from the flowers in this pouch and regurgitate it into the honey-cells on their return to the hive. The importance of this internal organ lies in the fact that certain chemical changes take place in the composition of the nectar, prior to its conversion into honey, during the short period the fluid is held in the pouch by the action of certain enzymes which are present there. This aspect is dealt with in detail in a later chapter.

CHAPTER II.

History of Bee-keeping and its Present Status in South India.

"The bees, rejoicing over their summer toils,
Unnumbered buds and flowers' delicious spoils,
Sealed up with frugal care in massive waxen piles,
Are doomed by man; the tyrant over the weak,
The death o'devils, smoored wi brimstone reek."

—Burns.

There is plenty of evidence to show that bees have been associated with man from the pre-historic days. The primative man appears to have been appropriating the hoardings of these industrious creatures to satisfy his craving for things sweet. Epics like Ramayana and the Vedas of the hoary past make mention of honey as a sweet food. Our ancients held honey-bees in a high esteem probably because of the various virtues displayed by them in their social life and of the valuable sweet product yielded by them. It is perhaps due to such ideas that the bee has been added as an insignia by great men. Figures and carvings of the honey-bee and its comb are said to appear in the tombs, coffins and crowns of the Egyptian Kings, on the arm of the Pope and on the Imperial robes of Napolean. In the Book of Proverbs, it is mentioned "My son, eat thou honey because it is good and the honey-comb which is sweet to thy taste." Mahomed the Great Prophet is said to have advocated the use of honey to his followers for various ailments. Hippocrates, Galen, Pliny, Celsis and others have recommended bee-tea from burnt bees as a remedy for kidney troubles and other ailments and also as a stimulant for the growth of hair. Numerous amusing anecdotes are also available about the utility of bees in warfare during the medieval period. Powerful invading armies had to suffer ignomious defeat and beat a hasty retreat as the beleagured garrison had the ingenuity to hurl a number of bee-hives over the heads of the enemy. The shield, mace, helmet and all the equipments of the army could not stand against the volleys of the stings of the infuriated bees. Natives of Africa, when engaged in their tribal feuds, are reported to resort to the clever strategy of upsetting their bee-hives in their villages before they desert them. Equally interesting are the records which show that bees were even used as executioners in the olden days. In spite of the fact that the virtues of honey-bees and honey have been known from the remote times, the methods of bee-keeping appear to have been very primitive and crude all over the world till recently.

In the Western countries the earliest method was to cut down hollow logs of wood tenanted by bees and keep them wherever desired. The next advancement was rearing the bees in crude rough boxes with a few cross sticks to support the weight of the combs. Along with these, the use of the conical bell-shaped earthenware or straw hives came into vogue. The straw hives are

known as 'skeps' and the use of these is said to be still prevalent in certain parts of Europe and America. A picture of such a skep can be seen in any of the elementary readers on Natural Science even to-day. These methods continued till the seventeenth century, when a hive with a movable top was devised. In 1789, Huber designed a hive with movable frames. Stimulated by this invention, a few other workers invented different models of hives on more or less the same principle. Sixty years later the Rev. L. L. Langstroth improved on the previous inventions and perfected the modern type of bee-hive with the movable frames. This completely revolutionized the aspect of bee-keeping from the primitive and barbarous methods to the perfect and profitable fine art of the present times. And to his genius bees and bee-keepers of to-day still owe a debt of gratitude since the use of the Langstroth hive and frames has become almost universal. In India, what little of artificial bee-keeping existed till now was carried on in the same old methods. A primitive method of rearing bees has been practised in Mysore, Coorg, Kashmir, parts of Malabar, Godavari, Visakhapatnam, etc., from very ancient days. Empty pots, hollowed out tree-trunks or any other suitable receptacles are smeared with wax on the inner side and kept in convenient and likely places in the jungles as decoys during the 'swarming' season. In course of time, these are taken possession of by swarms of bees and the tenanted receptacles are brought and kept wherever desired. Such colonies are left alone for a few months and when sufficient honey is gathered and stored, the bees are smoked away, the honey-combs taken and the honey squeezed out. This method is exceedingly common in Coorg and the sweet-scented leaves of 'Nerengi.' (*Cinnamomum iners*) are also used along with wax to entice the swarms. Some of the planters in favourable localities maintain up to a hundred of these pot-hives. A crude method of supering by placing an additional pot over the original one with a small hole on the top of the latter is also practised in certain places. Some of the localities are so favourable that an yield of even 30 lb. per pot is some times reported.

Though the efforts of the Government during the past century to give some impetus to this industry helped us to get some collected information on the subject, sufficient interest was not evinced by the public on the subject of bee-culture until very recently. The Imperial Entomologist, Pusa, started work with the Indian and Italian bees during 1907 and published his experiences in the Agricultural Journal of India, Volume VI, Part IV. In 1915, Ghosh published Pusa Bulletin No. 46, "Bee-keeping" and subsequently read the paper "Bee-keeping in India" before the Third Entomological Meeting, Pusa, 1919. By about the same time Lt. Cousins of the Punjab and Reverend Father Newton of Tiruchirappalli published their experiences, the former in a "A Guide to Bee-keeping in the hill districts of Northern India", 1916, and the latter in "The Domestication of the Indian Honey-bee", page 44, Agricultural Journal of India, Volume XII. In

1926, the writer attempted bee-keeping as a hobby and was able to rear Apis indica fairly well. Recent papers on the subject include (1) " Bees and Bee-keeping in South India " a popular account under the joint authorship of T. V. Ramakrishna Ayyar and the writer, published in the Madras Agricultural Journal, Volume XXII, 1933, and (2). Bulletin No. 10 " Bee-keeping " by the Mysore Entomologist, T. V. Subramaniam and B. Krishnamurthy, published as a Mysore Departmental Bulletin in 1933. A Bulletin by the Punjab Agricultural Department and a revised edition of the Pusa Bulletin No. 46 as Mis. Bulletin No. 6—Indian Council of Agricultural Research—are the recent additions. A few private gentlemen have recently contributed to the existing meagre list of literature on Indian bees. Taking our Presidency as a whole, the possibilities of this industry were practically unknown till about two decades ago, except for one or two enthusiasts who were maintaining a few hives. But the subsequent development has been something remarkable. Numerous apiaries have sprung up in almost all the favourable localities of the Presidency and the annual census of the hives maintained shows a steady increase of about a thousand hives per year. Most of the District Boards are taking a keen interest in the subject and are striving to introduce it as one of the items of vocational training in the elementary schools. A number of ashrams, sevasanghs, etc., which are being organized on philanthropic lines for the uplift of the poorer classes are very enthusiastic in advocating this industry as a profitable side-line. The recent advent of a few Bee-keepers' Associations, Co-operative Societies, as well as the All-India Bee-keepers' Association and the publication of its own journal bear ample testimony to the present prosperous condition of this fascinating hobby. The growing popularity is due to the fact that the Agricultural Departments of Madras and the States of Mysore and Travancore are taking active initiative in the matter. Credit is also due to the Y.M.C.A. authorities for encouraging and popularizing this industry as one of their rural reconstruction schemes. The main lines of propaganda adopted by the Madras Agricultural Department consist of rendering free advice and help in person wherever possible, supply of appliances, taking part in all the important exhibitions and fairs, celebration of honey-weeks, organizing free short courses on the subject, issue of cheap publications in English and the Vernaculars, etc. (Fig. 6). It is sincerely hoped that the present interest may not pass as a boom but might continue as a source of profit and pleasure and enrich the country's resources and relieve the ryot of his financial miseries to a certain extent. Before concluding this chapter, special mention has to be made of the creditable work of Rev. Fr. Newton of Tiruchirappalli, who was probably one of the first few to rear the Indian bee successfully in South India. His pioneer work and the article epitomising the results of his diligent application during the short spells of leisure he had, deserve to go down in the history of bee-keeping in South India.

CHAPTER III.

Different kind of Honey-Bees.

"Full nature swarms with life; one wondrous mas
Of animals."

—Thomson

Amongst the numerous kinds of bees found in India, the typical honey-bees (Frontispiece) which are social in habits comprise of four different forms, viz., (1) *Apis dorsata, F.* (the Rock bee), (2) *Apis indica, F.* (the Indian bee), (3) *Apis florea, F.* (the Little bee) and (4) *Melipona iridipennis Dal.* (the Dammar bee).

(1) *The Rock bee* (Apis dorsata, F.) (*Fig.* 7.).—This is the biggest of honey-bees and is a very good honey-gatherer. Each colony is capable of storing up to one or two kerosene tinfuls of honey and the Madras Forest Department is reported to collect annually up to 50,000 lb. mostly from these bees. Realizing the importance of this bee as a good honey-gatherer and pollinator, attempts were made as early as 1880 to introduce it into Europe and America without success. This bee builds its huge single combs in the open under overhanging rocks, branches of huge trees, sides of buildings, etc. In the comb, all the cells are of uniform size, there being no distinction between the worker, drone and queen-cells. The queen, the drone and the worker are more or less of the same size but the queen can be distinguished by the darker colour of her abdomen and the drone by the closer position of the eyes and the absence of the sting. In spite of its good honey gathering qualities, this bee has several undesirable traits which render it unfit for domestication. Forstly, it is exceedingly vicious in temperament and stings severely under the least provasation, sometimes resulting in the death of the victim. Of all things, the smell of tobacco smoke appears to irritate them most. Numerous accounts of the bitter experience of shikaries, who during their shooting expeditions in the jungles, had taken a short rest under some shady tree and lighted their pipes to have a cool smoke often appear in the press. Recently, the astounding news that a grown-up elephant was accounted for by an infuriated colony of these creatures is something incredible. Secondly, they build single combs, store honey and raise brood in the same and when honey is to be extracted the honey-bearing portions at the top have necessarily to be cut and squeezed out. Such squeezing and destruction of the combs is against the very fundamentals of scientific bee-keeping. Thirdly they construct their combs in the open and it is very unlikely that they would take to the enclosed conditions of a modern hive. And lastly they are migratory in habits. Since the publication of this Bulletin in 1939, some work

Recently Viswanathan, has recorded that this variety also constructs separate queen cells. (Indian Bee Journal, Vol. XII—1950—p. 55).

was done on the extraction and preservation of the honey from the combs of this variety of bee and a short account of the same is given in Appendix I.

(2) *The Indian bee* (Apis indica, F.) (*Fig.* 8).—This bee is smaller in size than the rock bee and differs fundamentally in its habits from its cousins. Unlike *A. dorsata* it establishes itself in enclosed spaces such as hollowed tree-trunks, cracks and crevices in walls, burrows in the ground and old pots and builds a number of parallel combs generally in line with the entrance. In strong colonies their number may vary from seven to ten. Brood-rearing is restricted to the central combs and honey and pollen are stored in the side ones. Under favourable conditions, it is a fairly good honey-gatherer and comparatively mild in temper. It is also not migratory in habits. Since the natural conditions are simulated in the artificial hive, this bee takes to it favourably and very little difficulty is, therefore, experienced in domesticating it.

Apis indica—*Hill variety*.—A dark variety of *Apis indica* occurs in the hilly regions. The following are some of the differentiating features, in their habits as compared with those of their cousins of the Plains. The Hill bee is bigger in size and darker in colour. There is a slight variation in their comb-building habits also. The plains bee invariably erects its combs in a line parallel to the direction of the entrance whereas the hill bee, while having similar habits, often constructs its combs also at right angles to the entrance. Its temper in its natural habitat is in no way commendable and it is particularly vicious during the swarming season. These bees are also shy and timid in their habits, and try to sneak away even from the brood-combs at the slightest disturbance; while the plains bees rarely desert their combs unless purposely driven off. The queen is jet black in colour. She is equally shy and considerable difficulty is often experienced in spotting her out. One of these colonies was brought down from the hills and kept under observation at Coimbatore. It was found to be quite docile more prolific in breeding with a better capacity for work. During the first year its yield of honey was double that of the best colony of the plains bee. But these observations could not be confirmed since the colony perished during the next season. Further trials with a few more stocks brought from the hills were not successful.

(3) *The Little bee* (Apis florea, F.) (*Fig.* 9).—This is the smallest of the three species of Apis and a poor honey-gatherer but the honey is supposed to be very sweet and possess medicinal properties. It constructs its tiny single combs on twigs, bushes, eaves of buildings, etc. Since its comb-building and migratory habits are more or less similar to those of the Rock bee, it is likewise unfit for domestication.

(4) *The Dammar bee* (Melipona iridipennis. Dall) (*Fig.* 10).—This is a tiny dark creature belonging to the genus Melipona. It differs from the bees mentioned above in its external appearance

as well as in its habits. The sting is not well-developed in this species and it is, therefore, not capable of inflicting any pain. But when the colonies are disturbed, a number of bees hover over the face and cause annoyance, sometimes biting with their mouth-parts. It inhabits crevices in walls, hollow trunks of trees, etc. the method of comb-construction is entirely different from that of the other species. The combs are made of a mixture of earth or resin and wax, the latter being secreted both by the males and workers from the glands situated between the abdominal plates. The brood cells are constructed individually in the shape of tiny ellipsoid pellets, all joined together with bits of wax and resin, the whole presenting the appearance of part of a cholam earhead. Honey and pollen are stored separately in groups of cells bigger in size, globular in shape and darker in colour; very much resembling a bunch of small grapes. Though its honey is supposed to have high medicinal properties, this bee gathers it in such small quantities that it looks almost a pity to ruin a colony for the sake of one or two ounces of the produce. It is not, therefore, worth-while keeping this bee also.

Practically speaking, therefore, the only one variety which offers promise of satisfactory domestication as a honey-bee is the Indian bee (*Apis indict*, F). The following chapters, therefore, refer to this species only.

CHAPTER IV.

THE BEE COLONY, ITS DIFFERENT MEMBERS AND THEIR LIFE HISTORY.

> "There is difference between a grub and a butterfly;
> Yet your butterfly was a grub."
>
> —SHAKESPEARE.

All the four different kinds of Indian bees described in Chapter III, though differing in their habits, are social insects, i.e., they live in colonies. Of these, the Indian bee (Apis indica F) in its wild haunts, as already mentioned, takes up its residence in well-protected, enclosed places such as inside crevices of buildings, hollowed tree-trunks, burrows in the ground, etc. Inside such receptacles, it builds a series of parallel combs with wax, a substance secreted by the bees themselves. The combs consist of thousands of bexagonal cells, each comb having a double set of them, one in each surface with a partition at the middle. These cells serve as cradles for rearing the young ones and for storing their food-materials. The majority of the population of a storing bee colony which sometimes reaches 30 to 40 thousands, will be found clustering together round these combs, presenting

an appearance of a hemispherical mass. This population consists of three different categories, the worker, the drone and the queen (Frontispiece).

The worker.—The workers are active little creatures commonly found visiting various flowers, gathering pollen and honey. They have a dark-coloured thorax covered with light brown hairs and a tawny coloured abdomen with dark bands. The newly emerged bees are called " nurse bees " as they remain indoors for about 13 days attending to the domestic duties such as looking after the grubs, building combs, ripening honey, etc. The body colour of the bees at this stage is somewhat dull and lacks the metallic lustre of the field bee. In very old bees, the abdomen gets contracted, presenting a dark appearance. This is due to the telescoping of the abdominal segments when the tawny coloured portions are hidden exposing only the dark bands. The workers, old and young, form the bulk of the colony. They are the " dictators " of the policy of the colony and on them rest the important duties such as gathering honey and pollen, constructing combs, rearing brood, defending the colony against enemies, keeping the home warm and in a sanitary condition, etc. To perform these duties satisfactorily they are provided with the necessary structural adaptations. They are immature females in sex and hence incapable of reproducing their own kind. But, in queenless colonies, they sometimes take the role of the queen and lay numbers of unfertilized eggs in the cells but only drones develop out of them.

The drone.—This is the male bee and is bigger in size and darker in colour than the worker. The drones are not permanent members of a colony but are raised only during certain seasons when new queens are reared. They are sluggish in habits and remain indoors for most of the day but invariably join the workers in their " play-flights " during the evenings. They do not possess any of the structural adaptations like the workers and are, therefore, neither capable of collecting their own food nor defending themselves against enemies. Their only function in life is to fertilize the virgin queen.

The queen.—Every normal colony should have a queen as she is the only individual capable of reproducing the species. Colonies without queens rapidly die off. A well-develped specimen is generally two or three times the size of a worker. Her head and thorax are dark in colour and sparsely hairy and the abdomen and legs uniformly coppery brown. She could be easily distinguished from the other bees by her distended abdomen without the black bands on it and the brown legs. She is also provided with a combined sting and ovipositor. She is generally found on the brood-combs steadily moving about, examining the cells and laying an egg in each.

Life-history of the queen, (Fig. 11).—When the colony wants to produce new queens, special cells known as " queen-cells " are

constructed generally along the lower border of the brood combs and the reigning queen lays an egg in each cell. The grub hatches out in three days and it can be seen curled up at the bottom of the cell in the midst of a gelatinous layer of food-material. The latter is a secretion from certain glands situated on the heads of the nurse bees. It is highly nitrogenous and is popularly known as "bee-milk" or "royal-jelly". The queen-grub is fed on this material and attains full-growth in about five to six days after which the cell is capped. The inmate undergoes a metamorphosis and changes itself into what is called a "pupa". This stage has a well-defined head, thorax, abdomen and legs and has, therefore, a greater resemblance to the adult. After about a week, the full-fledged queen comes out after biting open the tip of the cell which opens out like a hinged lid. The young queen, on her emergence, is scarcely bigger than the worker with faint, dark bands on the abdomen. The characteristic coppery brown colour and the plumpy shape develop only after mating. Within about a week she goes out accompanied by a retinue of drones on what is known as her "nuptial flight". She is a very fast flier and only strong drones will be able to keep pace with her. Ultimately she gets mated by one of the strongest of the males and the latter dies soon after. The mated queen returns to the hive and begins to lay eggs, in two or three days. If the queen does not succeed in finding a mate on the first day, she is said to go out again on the succeeding days for about three weeks until she gets mated. If within this period she does not come across a drone she must remain a virgin for life but this contingency does not generally arise since there is always a superfluity of drones during the queen-rearing season. The queen gets mated only once in her life-time and the seminal fluid imparted by the drone is stored in special receptacles known as "spermathecæ" present in her generative system. The queen-bee, as in the case of that of other social insects such as ants, termites, etc., has the facultative reproductive capacity. She can, at her will either get the eggs fertilized by the male sperm or not as they pass out from the ovaries. Workers and queens, i.e., females, are raised from fertilised eggs and drones out of unfertilized eggs. If a queen is to be reared, the egg is laid in the queen-cell and the grub, on hatching, is fed exclusively on the rich nitrogenous "royal-jelly" and in the case of workers, the same fertilized egg is laid in a smaller cell and the larva is fed only on a less nutritious food. Thus it is clear that the egg for raising either a queen or a worker is the same but the difference lies in the accommodation and quality of food. If drones are required, cells slightly bigger than those of the worker are constructed and an unfertilized egg is laid in each. The daily rate of egg-laying by the queen varies according to the availability of pasturage. During favourable seasons the average rate is about 300 per day, the maximum being about 500, but under adverse conditions it is reduced to 30 to 40 or even less per day. Compared with the queen of the Italian bee, whose egg-laying

capacity is reported to exseed 3,000 a day the fecundity of the queen of the Indian bee is very poor. The longevity of the Indian queen bee extends for two or three years.

Life-history of the worker (*Figs.* 12 *and* 13).—In a honey-comb most of the cells are constructed for the worker-brood at the rate of about 39 cells per square inch. The queen lays a fertilized egg in each cell. The grub hatches out in three days and as it is not capable of moving about and getting its food, the nurse bees feed it carefully. It gets full-grown in four days after which the cell is sealed by the workers. The grub subsequently transforms itself into a pupa from which the full-fledged bee emerges in twelve days. According to literature on European bees, the grub is fed on royal-jelly during its earlier stages and on a mixture of honey and pollen, popularly known as "bee-bread" during the subsequent days. The longevity of the worker varies from 45 to 80 days. In the case of neglected queenless colonies their span of life appears to extend up to six months probably due to the conservation of their energy on account of the enforced idleness.

Life history of the drone (*Fig.* 11).—Drones are raised only during certain seasons, i.e., just prior to the construction of the queen cells. Special cells, at the rate of 36 per square inch, are constructed and an unfertilized egg is laid in each. The life-cycle of the drone is slightly longer than that of the worker. The grub hatches out in three days. It is fed by the bees for five days by which time it gets full grown. The cell is then sealed and the inmate undergoes the pupal stage. The adult emerges in thirteen days. In the case of the foreign bee the grub is fed on royal-jelly for three days and for the next four days it is given a mixture of bee-bread and royal-jelly. The drone larvæ are fed better probably to raise strong and well-developed males for mating with the future queens. The longevity of the drone was found to extend up to 60 days.

Difference between the worker and the drone (*Fig.* 14).—There is no external difference in the larval stages of the drones and the workers, except that the former are slightly bigger in size and are reared in larger cells. But the difference in the capping of the cells is obvious. In the case of the worker-cells, the sealing is flat and in level with the comb, whereas in the drone-cells it protrudes, very often with a black spot and a small hole at the centre. The eyes nearly meet on the dorsal side of the head both in the pupal and adult stages of the drone, but in the worker they are apart. It is impossible to mistake one for the other in the adult stage. The worker is smaller in size, brown in colour, provided with a sting and can be commonly seen flying about. The drones are bigger in size, dark in colour and do not possess either the stings or any of the other structural advantages. They come out of the hives only during the evenings for their play flight.

Before concluding this chapter, the following information regarding the population of the different categories, brood-area,

food stores and the foraging activities of a thriving colony at the peak of its activity may be of some interest. The total population consisted of 32,787 of which 16,497 were field bees, i.e., capable of flying out and 16,296 house bees thus showing that the categories were of approximately equal strength. The worker-brood area extended over 276·9 square inches having 10,799 cells and that of the drone 54·2 square inches having 1,951 cells. The inmates of the cells were in different stages of development. The pollen stock was stored over an area of 30·3 square inches (1,181 cells). Honey was found stored over about 420 square inches, 140 square inches being in the brood-combs and 280 in the super. Incidentally the actual number of trips performed by the bees for the collection of nectar and pollen was counted in another colony having a total strength of 14,135 bees. Five thousand, five hundred and eighty-two trips for pollen and 18,907 trips for nectar were performed in the course of one day.

CHAPTER V.

DOMESTIC ECONOMY AND HABITS OF THE HONEY-BEE.

"He must be a dull man who can examine the exquisite structure of a comb so beautifully adopted to its end, without enthusiastic admiration."

—DARWIN.

The co-operation and division of labour among the different members of a colony of bees, the assiduous industry, sacrifice, devotion and intelligence shown in the discharge of their duties and the resultant perfection of organization have all been the object of wonder and admiration to all men and especially to naturalists from time immemorial.

In a hive, in this little world of bees, the queen is the idol and her devotees, the workers, will fight to the last individual in protecting her. Should a wild colony be disturbed, the bees will rather desert their abode leaving all the provisions and their progeny than expose their queen to the danger of destruction or capture. They follow her wherever she goes and cluster round her person. Under such circumstances if the queen is missing they immediately begin to search for her, and even if they get tired in their attempts, they rest for a while, and continue their quest until they find and cluster round her. The queen, on her part, reciprocates all the love and care bestowed on her by sticking to her duty of egg-laying with unparallelled devotion. During the busy breeding season when bee colonies divide and distribute themselves (popularly known as "swarming" detailed in Chapter X), the queen lays eggs in the queen-cells at the bidding of the workers as it were, and waits for the development of her daughters with almost a philosophic fortitude, knowing perhaps fully well that she has to clear out very soon

from her home, where she has been reigning so long and face the risks and adversities attendant on a new venture. When a normal colony happens to lose its queen, all on a sudden, the first instinct of the workers is to raise a substitute. They try to rear one out of a young worker larva by slightly enlarging the cell and by giving the grub the extra nutritious food. In some cases they construct queen-cells along the lower border of the comb and even transport a few fertilized eggs or young grubs to them. If they fail in their attempts, they become rather morose, neither feed nor work properly and put on, as it were, a mourning coat by gradually turning black in colour. In the meanwhile some of the bees, popularly known as "laying workers" in their frantic anxiety to keep up the strength of the colony, take up the role of the queen and begin to lay eggs. But they do it so indiscriminately that up to a dozen of the eggs are often found in each cell. The bees discard the superfluous number leaving only one egg in each cell. Scores of the rejected eggs may be found strewn over the floor-board. In due course grubs hatch out of the eggs in the cells but as they are unfertilized, they develop only into drones.

As a rule, there can be only one queen for a colony. This is perhaps another wonder in the evolution of the habits of these social insects. The importance of the queen is realized to such an extent that the bees probably take it that an additional member of this important category in a colony is a luxury which they cannot afford and that she would fulfil her duties better in a separate colony of her own. On account of this primary instinct, bees seldom tolerate a second queen in a colony. This condition arises only during the swarming season when the reigning queen and a number of her daughters in their younger stages occur at the same time. But the former invariably departs with the prime swarm, before her daughters emerge from their cells. The new queens, which emerge subsequently go out in their turn with the secondary swarms. The possibility of the presence of more than one queen at a time in a hive is thus obviated. If by some chance there happens to be two healthy queens in a colony they begin to fight immediately and one of them is accounted for very soon. The animosity does not stop with the adults but is even extended to the younger stages also. A new queen may, on her emergence, take it into her head to wipe out even a chance of her rivals coming into existence in the same colony and sting the inmates of the queen-cells and some times even tear the cells to pieces. But this happens only in cases where the colony has become too weak to send further swarms. A peculiar feature about the sting of the queen is that it is a little curved and provided with fewer barbs than that of the worker (Fig. 5). This probably helps her to retain the organ even after use for her primary function of laying eggs, while in the worker the whole mechanism is left behind on the attacked spot. A more interesting point with the queen is that she uses her weapon only against her own rivals and seldom

against any other members of the colony. In rare cases, when she gets too old for egg-laying one may find her young daughter also in the same hive for a few days. It is very probable that the mother waits until her successor is fit to take charge of the colony and then, in the interests of the colony, allows herself to be killed by her own daughter. But in very exceptional cases, 2 sometimes even 4 or 5 healthy queens are found in one colony, all carrying their egg-laying functions quite normally.

Now coming to the workers which form the bulk of the colony, the full brunt of the upkeep and support of the hive falls on their shoulders, the various structural adoptations possessed y them coming in handy to execute their functions satisfactorily. One of their most important duties is the building of combs and this is taken up mostly by the young members. The combs, as already mentioned, are made of wax, which is a secretion of the wax glands (Fig. 4). The mathematical accuracy with which the cells are arranged and the high mechanical principle involved in designing the peculiar shape of the cells are features perplexing human mathematical genius. The hexagonal shape of the cells provides the maximum space with the minimum material, at the same time rendering the cells sufficiently strong to withstand pressure from all the sides. Considerable intelligence and forethought is also evinced in designing the shape and size of the cells to suit the future requirements of the colony. For rearing a queen, they erect larger cells along the lower extremity of the brood-combs free from congestion but at the same time well protected. The drone and the worker cells are shaped to suit the size of the future occupants. A few rows of cells in the higher portions of the brood-combs serve the purpose of the larder of the colony for storing honey and pollen. These cells are about the same size as the worker-cells but the mouth is often rounded and thickened in the shape of a rim. Combs when fresh are soft and pure white in colour and are capable of bearing the weight of only honey which is generally stored in them. The brood-cells are rendered more rigid and strong by repeated coatings of what is known as " propolis " as they have to bear a heavier load. This substance consists of a gummy exudation from some plants and trees and is collected and brought by the bees in their pollen-baskets. New combs with their first coat of propolis are yellow to brownish in colour and the old ones get quite rigid, hard and dark in colour by the repeated application of this gummy and hard substance.

Next to comb-building, the most important duty is the collection of the food-materials consisting of pollen and nectar, both of which are available from flowers. As already mentioned, the workers have a special adaptation in their hind legs—the pollen-baskets—which serve as receptacles for bringing the pollen from the field. The method of pollen collection varies according to the structure of the flower and the process itself is quite interesting. A description of the same is given below. (Figs. 15 and 16.) A pollen gatherer is

said first to take a good drink of honey prior to going out for work. On selecting a suitable flower in the field, she gets into it and rubs herself against the anthers sometimes biting open a few. During this process, the headfi mouthparts, antennæ and thorax, in short the whole body, gets smeared with the fine dust. The easy adherance of the grains is effected by the presence of innumerable tiny hairs all over the body of the bee. The next process is the wiping down of the pollen and packing it in the two pollen-baskets. This is accomplished with the help of the pollen brushes present on the fifth joint of the first two pairs of legs, mostly when the bee is on the wing poising herself in the air. In some cases she may suspend herself from a leaf with one of her forelimbs while the pollen is brushed down and packed by the free legs. While the bee brushes down the fine grains adhering to the head and mouthparts she is said to vomit a little of the honey she had already taken and moisten the dry powder. When the bee visits flowers yielding both nectar and pollen, the nectar in the flower is used for this purpose. In either case the moist pollen is again kneaded with the dry stuff already adhering to the other parts of the body to the required consistency and then packed in the pollen-baskets. The bee may repeat the process in the same flower or visit a few more flowers until a sufficient quantity is gathered for the trip. After getting a full load she returns to the hive, selects a storage cell and deposits her load there as detailed below. She first grasps the upper rim and the cell immediately above the selected one with her forelegs and rests the tip of her abdomen in the lower cell. Next she thrusts the middle and hind pairs of legs into the cell between the two and removes the two tiny pellets of pollen with the middle pair of legs. Having deposited her load, the bee goes out again for further collection. Some of the house-bees attend to the packing of the loose pellets compactly in the cells.

The older and more experienced bees go out for nectar collection. On selecting a flower, the worker inserts her tongue into the nectary and sucks the sweet fluid. After gathering a sufficient quantity, she flies back to the hive and regurgitates the fluid into the cells. The number of nectar gatherers is invariably higher than that of the pollen carriers as Fig. 17 would show. Details of the conversion of the nectar into honey inside the stomach of the bee are explained in Chapter XI.

When the bees have done a good morning's work and collected enough nectar, some of them take up their position at the entrance of the hive during the afternoons and flutter their wings at a very rapid rate. By this action a current of fresh air is sent in and another set of bees above fan out the air by the same process, thus creating a continuous draught of fresh air. The dry air absorbs the superfluous moisture contained in the honey and renders it fit for storing. The same activity may be noted during the hot weather also to provide the necessary ventilation for the hive.

The sealing of the honey-cells when they are full of concentrated ripe honey and the brood-cells when the larvæ are mature is attended to by the young workers. The material used for sealing the honey-cells consists of pure wax and hence the capping is somewhat translucent, while for the brood-cells a mixture of pollen and wax is used which renders it opaque.

Besides comb-building and foraging, the workers have many other duties. Bees love their homes and jealously guard them. They are provided with the organs of defence to protect the colony from intruders. If by any chance any bee from any other colony, or any stranger comes near the entrance there is immediately a commotion. In the fraction of a second the fighting forces are marshalled and the enemy is either killed or driven away promptly.

The hive-temperature, as recorded by a Centrigrade thermometer inserted and kept permanently in a hive, was maintained consistently between 33° C. and 36° C. irrespective of the external conditions. This higher temperature which is required for the proper development of the brood is maintained by the workers clustering together over the combs. An abnormal rise in the temperature is noted immediately before and during the issue of a swarm, probably due to the feverish activity of the bees in their haste to depart.

The maintenance of sanitary conditions, repairs and upkeep of their little home form other items in the daily routine of the workers. No extraneous or dead matter is tolerated inside their dwelling. Carcasses of bees and grubs, if any, are immediately brought out and even taken to long distances and thrown away. Holes or chinks likely to cause any discomfort to the colony are promptly closed with wax.

The principal domestic duties of the young bees, as observed in the case of the European bees, are as follows :—

(1) From the first to the third day, they prepare the empty cells for the brood and assist in incubating by maintaining the hive temperature.

(2) From the third to the sixth day they feed the older larvæ with pollen and honey.

(3) From the 6th to the 10th or 15th day they feed the young larvæ with royal-jelly now generally considered to be a special secretion of the pharyngeal glands, which are in a state of maximum activity in bees of this age.

(4) From the 10th to the 20th day they are engaged in various domestic duties including the receiving of honey from the field bees and ripening it and the secretion of wax.

Older bees can produce both brood-food and wax provided the respective glands are not worn out and atrophied. There is considerable overlapping, in respect of the exercise of these two functions, especially in times of comparative inactivity.

The following data are available for the Indian bee. The indoor activities of the young bees extend up to 13 days from their emergence. The main functions attended to at this etage are tending the eggs, feeding the grubs, secreting wax and constructing of combs, receiving and ripening the nectar and guarding the entrance. No definite information is available regarding the exact age of the bees attending to the different functions mentioned above and in most cases overlapping of the duties was noted. After the completion of the house-bee, stage, the bees learn to fly and disport themselves outside the hive for four or five days probably to study the locality and get initiated in the are of foraging. Pollen collection commences after this period of apprenticeship and goes on for about twenty days. The more important duty of nectar collection is taken up later. This is the normal trend but there may be exceptions.

Besides their scrupulous attention to the routine functions, one cannot but appreciate and wonder at the atmosphere of amicability and harmony prevailing in a bee colony. The mutual affection between the different members is worth studying and their attachment to their young is remarkable. They tolerate any amount of handling of the honey-combs but will resent meddling with their brood which shows their greater attachment to the young ones than to the food supplies. Another instance of their great attachment is shown when bees are forced by circumstances to desert the hive. In carelessly kept colonies the " Wax-moth " invariably gets in and the poor bees are helpless against this enemy. As soon as the colony is infested, the bees make up their minds to desert the hive and seek accommodation elsewhere. The queen immediately stops egg-laying and the workers, under great difficulty and inconvenience, wait until the last grub emerges as an adult and is able to accompany them. Only in a very few cases they leave behind a healthy grub or pupa.

The sympathy which the workers have towards their defenceless brethren, the drones, is another remarkable feature. These are raised only during the season of honey-flow and serve no useful purpose to the colony after fertilizing the queen. The workers being provided with a very effective weapon in the shape of the sting, one would naturally expect a massacre of these undesirables in times of scarcity. But it rarely occurs. When the food-materials are nearing exhaustion, the drones are gently brought out and driven away to shift for themselves. (Fig. 18.) These exiles very often enter other hives where there is enough food and continue their lazy and indolent life. Workers from one colony will not ordinarily be tolerated in another, but the entry of the drones is scarcely taken notice of. While the tolerance or expulsion of the drones is a common feature, occasionally the workers do resort to a wholesale slaughter of the adults as ell as the pupal stages, probably as an inevitable measure.

Another extraordinary instance of the spirit of fraternity is sometimes observed. When one of two wild colonies found side by side is disturbed, a large number of bees will naturally issue from it and fly about. The frightened workers, under the principle of " safety first ", will not hesitate to enter the adjacent hive leaving behind their combs, brood and sometimes even the queen. What is more wonderful is that the rightful occupants of the other nest shake off their prejudices and tolerate the refugees, as if lending a helping hand to their brethren in distress. In combination with these inimitable qualities, they exhibit a foresight and shrewdness, the importance of which in their struggle for existence, cannot be overestimated. Like other Nature's creatures they provide against accidents. Swarming is a provision for dispersal and propagation of the race. A liberal budgeting is made for this. More queen-cells, than are compatible with the strength of the colony, are constructed to guard against death or ill-development. And to provide a proper mate for the queen, a very large number of drones are reared beforehand. Their habit of collecting and storing their food for a rainy day even far in excess of their requirements is another classical example of diligence, forethought, prudence and thrift.

General habits of bees.—An accurate knowledge of the habits of the bees is necessary for outwitting and robbing them of their hoardings. Chapter X dealing with the various manipulations for the successful management of apiary is based on the habits of bees and on their response to human handling and environments such as weather, pasturage, etc.

Habits of dispersal and distribution.—When, due to favourable weather and pasturage conditions, the population of bee-colonies increases enormously, the members get an instinctive desire to divide and distribute themselves. The division takes places in the form of " swarms " which issue from the existing colonies. These swarms generally come out during bright mornings and settle in the open in a bag-like cluster. Some of the workers are, in the meanwhile, sent out as scouts to select a place for their future residence. On selecting a new site such as the hollow of a tree, an old pot, etc., the scouts return and inform the rest of the happy tidings. Thereafter the whole lot moves away direct to the new locality, settle down there and the workers immediately start comb-building. The time taken by the scout-bees to select the site seems to vary from 15 minutes to even 24 hours. Longer stays of the swarm in the open obviously indicates that the scouts have not yet decided about the future place of residence. The workers drink plenty of honey prior to swarming to provide against such long delays and also to facilitate the copious secretion of wax for the construction of combs in their new home.

Food of bees.—Prosperous colonies gather enormous quantities of pollen and honey for their food. The bees mostly feed on the honey and the grubs are fed on a mixture of the two. Under favourable conditions they store larger quantities of honey while

pollen appears to be consumed as it is gathered. This instinct of gathering honey in excess of their requirements is taken advantage of under artificial conditions and whatever surplus which can conveniently be taken without starving the bees goes to enrich the owner of the hive.

Homing instinct.—The strong homing instinct of the honey-bee is another notable feature and this aspect is dealt with subsequently under " Shifting bee-colonies ".

Anger of bees.—Bees, by nature are quite amenable to domestication and only bad weather conditions and injudicious handling make them cross. By a little experience the operator can find out their mood on opening the hive itself. If the bees are in good mood, they fold their wings and timidly hustle away inside. On a closer examination, they will be found grabbing the nearest honey-cell greedily drinking the honey and shaking their abdomen in contentment. If, on the other hand, they are in a surly mood, they do not brook any intrusion. On opening the hive, the workers on the top of the frames do not sneak in but openly defy the intruder with their wings, abdomen and legs erect and rigid. It is quite easy to perceive the sinister gleam in their eyes and if the inexperienced enthusiast still persists in disturbing them, they advance towards him menacingly. In the meanwhile, news of the impending danger is telegraphed down in their own wonderful code and larger numbers come up all in an equally bad mood. If the person does not realize even now, then woe unto him. The bees dart with lightning rapidity right on his face, generally near the eyes or lips, and before he realizes what it is, a few of the painful bags of poison are left behind. It may be incidentally mentioned here that a bee is absolutely harmless after it loses its sting and has to eventually die due to the amputation of the defensive weapon. But the temper of the infuriated creature, though it is rendered harmless, does not easily cool down as it may, in its impotent rage, continue to harass the person, by darting over his face and hands.

Hive odour.—The workers and queen of every colony possess a particular smell of their own, which emanates from the scent glands. This smell is popularly known as the ' hive odour '. It is already an established fact that bees, with the help of this odour, are able to detect the presence of strangers in their midst and also spot out places of favourable pasturage already visited by them. The peculiar odour is not present in the combs nor is it developed in the case of the brood, young bees and drones. While the hive-odour-discrimination among the old workers is an accepted fact, bees in their ordinary routine of life do not seem to exercise this faculty to any considerable extent, as the drifting of bees from one colony to another is a common occurrence especially during the honey-season. Foraging bees returning with pollen and honey as well as those coming back from their evening play-flights are scarcely taken notice of by the inmates of whichever hive they may enter. Even a deliberate interchange in the position of two

hives, made at a time when the bees are at the height of their field activities, does not result in any fighting. The foragers, on their return, straightaway enter the hive and continue their activities, there being no objection from the occupants, though both are absolute strangers. But if the interchange is done after slightly distracting them from their regular duties, the strangers in each colony are promptly recognized and dealt with accordingly and it looks as though the strangers are detected more by their timid behaviour than by the odour itself. Strangely enough, bees are also not able to detect strangers in their midst when in excitement and confusion brought about by their natural or artificial causes. A common example of this is the mixing of natural swarms during their swarming flight when they issue simultaneously from hives kept nearby. Similar cases occur when, under heat of excitement two or more deserting colonies freely mix in the air and settle as one group in spite of their individual hive odours. A liberal application of smoke also makes them forget this instinct but this should be done with care. These factors have to be borne in mind when uniting bee-colonies.

Range of flight.—A knowledge of the range of flight of the bees is necessary for selecting the site for an apiary. The European bee is said to travel up to two miles for foraging; but the longest distance travelled by its Indian cousin has been found to be only nine furlongs. This distance represents only its maximum capacity and it is needless to mention here that the field of pasturage should be as near to the apiary as possible so as to run it profitably and efficiently.

Gregarious habits.—Honey-bees are social insects and live together. Whatever may be the conditions, they always remain huddled together except when they go out foraging. Their habit of clustering round the queen is very characteristic, but even in the absence of the queen and the combs, they have a tendency to crowd and settle in a group. This particular habit is often very advantageous in hiving wild colonies.

Language and communications.—Insects like crickets, cicadas, etc., have their own methods of communication mostly for the attraction of the other sex. But in the case of social insects like honey-bees, ants and termites, the means of communication are very highly developed. Nothing is kept as a secret in their little world and any news good or bad is immediately communicated to the rest. The actual method of communication, i.e., the language. may differ according to the insect. The honey-bee is said to adopt a system of dances for the purpose. The discovery of a rich field of pasturage by a worker is immediately communicated to the rest by a particular dance and bees are said to have evolved separate dances for communicating the discovery of honey and pollen pasturages.

Idiosyncracies.—Colonies under identical conditions, receiving the same treatment sometimes behave quite differently. In an

apiary, in the midst of several flourishing colonies, one or two may refuse to increase in strength. Secondly some colonies may be found to multiply as rapidly as others but their honey gathering may not be in proportion to their strength, while hives with a weaker population may yield more honey. Thirdly, some colonies are naturally vicious and sting on the least provocation. Most of these drawbacks, which are generally inherited from the queen, can be easily rectified by removing the existing one and supplying a fresh one from another colony having more desirable traits such as mild temper, good honey gathering and non-swarming propensities, etc.

Response of the bees to environments.—Of all the factors that influence bee activity, the availability of pasturage is perhaps the most important. Granting that the food materials are available in plenty in the field, their collection has been found to be influenced, within certain limits, by a few factors like temperature, relative humidity, high winds, success or otherwise of the previous monsoon, receipt of sharp showers, and finally the strength of the colony itself. Bees have been found to be most active in the collection of nectar and pollen within a range of 76° to 80° F. temperature in the shade. High pollen activity was noted within a range of 76 to 80 per cent relative humidity, while maximum nectar collection was noted between 71 to 80 per cent. These weather conditions are prevalent mostly in the mornings between 8 and 10 a.m. at the time when flowers of most plants are open and are afresh and the peak of bee activity also synchronises with this period. High winds as they occur in Coimbatore during June, July and August are serious impediments to bee activity since it is difficult for the bees to go out on most of these days. The success or otherwise of the preceding monsoon has an indirect influence on the progress of the bees during the next season. A good monsoon results in a luxuriant vegetation and this is favourable for the bees. The immediate effect of a sharp shower is more spectacular. Numerous ornamental plants, weeds and avenue trees put forth luxuriant growth and flower after every good rain. Accelerated bee activity is a common experience during such periods. The relative strength of colonies also has a strong bearing on the foraging activities as it has been definitely found that the number of foragers is directly proportionate to the population of the colony. Besides these, it is a well-known fact that bees are essentially sun-loving creatures. But they do not like the midday heat nor do they exhibit much activity during the cold and chill mornings or on rainy days. During summer they start work by day-break and stop by about 10 a.m., while during cold weather they begin a little later and continue for a longer time. It has, however, to be reiterated here that these weather factors are more complimentary and that the availability of pasturage in the field is after all the most important stimulus for field work.

CHAPTER VI.

Enemies of Bees.

"For not a creature lives beneath the sun
But has some dangers every day to run."

—Knipe—Nebula to Man.

The Indian bee is singularly free from any infectious disease, whereas the European species are subject to a variety of maladies such as Foul brood, Sac brood, Nosema disease, etc., which cause complete destruction of the colonies and are exceedingly difficult to control.

The following represent the insect and other enemies of bees noted so far, at Coimbatore :—

(1) The wax-moth (*Galleria mellonella Linn.*).
(2) The black ant (*Camponotus compressus Fabr.*).
(3) The bee-hunter wasp (*Philanthus ramakrishnae T.*).
(4) The smaller bee-hunter wasp (*Palarus orientalis Kohl.*).
(5) The yellow banded hornet (*Vespa cincta Fabr.*).
(6) The Death's head moth (*Acherontia styx Westw.*).
(7) The lesser wax-moth (*Achroia grisella F.*).
(8) The wax-beetle (*Platybolium alvearium Blair*).
(9) Cockroaches.
(10) The leaf-cutter bee (*Megachile disjuncta F.*).
(11) Different species of small ants.
(12) Blood-suckers and lizards.
(13 Bee-catchers (birds); The Drongo (*Dicrurus ater*) and the Bee-eater (*Merops viridis*).

(1) *The wax-moth* (*Figs.* 19 *and* 20).—This is the worst scourge of bees causing wholesale damage to their colonies, wherever it is left unchecked. It freely attacks combs of all the three species of Apis. Its occurrence has been noted from the very early days of Roman and Grecian civilization. Aristotle, Virgil, Columella and Pliny have recorded the wax-moth in their ancient writings as early as 384–322 and 70–19 B.C., and 1–68 and 23–79 A.D. respectively. The pest has been reported from almost all countries of the World but its actual distribution is said to be restricted to warm climates and low altitudes. Exceedingly damp localities are said to be unfavourable for it. In South India the pest is very serious in all the districts of the plains from July to October, but it has not been noted so far on the Nilgiris though bee-colonies occur there in plenty. Occasionally a Braconid parasite has been found to parasitise the caterpillars, but it does not seem to be capable of keeping down their number to any appreciable extent. The real damage is caused by the caterpillars only. These manage to reach the combs and tunnel down gradually, weaving a silken gallery for themselves, inside which they are comparatively safe from any molestation by the bees. Combs in the early stages of infestation

indicate only the trace of the damage inside by the presence of a faint webbing over a few cells. But in the course of a fortnight the destruction is complete, only fragments of the combs being left behind amidst the tangled mass of whitish webbing. The Indian bee, so far it has been observed, does not seem to be capable of either withstanding the pest or eliminating the caterpillars from its combs. Infested colonies very soon stop their usual activities and within a short time the bees desert their nests. The moth is a stoutly built insect having a wing expanse of about one inch. The fore-wings are ashy grey in colour, mottled with bronze coloured bars, the hind wings being uniformly greyish. The female is larger than the male, and the main distinguishing feature between the two sexes is that the outer edges of the forewings of the male are a little concave, while in the female they are straight. The moths are active during night time only, but may occasionally be seen resting on the hives during day time also.

Life-history—Egg-laying habits.—The female prefers to lay eggs in hidden and safe corners. Several pairs of moths were kept in jars, with a piece of comb inside, to observe their egg-laying habits. The eggs were mostly found thrust between the muslin cover and the rim of the jar. The few which were laid on the combs were hidden under the fringes of broken margins, and under the cell-walls which were pressed down a little in the handling. Though combs under different conditions such as new combs, old combs, old combs with plenty of propolis, old combs with plenty of pollen and honey stocked by the bees, etc., were kept in the jars, they failed to attract the moths so long as there were other places more safe for oviposition. When infesting colonies housed in the artificial hive, the moths were found definitely to prefer the narrow slits between the brood-chamber and the super or the top as well as the hair-breadth spaces between the joints. Very often numbers of these egg-masses were found inside crevices which would hardly admit the slender ovipositor of the moth.

The eggs are small about $\frac{1}{2}$ m.m. in length, pinkish white in colour, always laid in groups varying from a few up to 500 and firmly attached to the surface with a gummy substance. The moths begin to oviposit the next day after their emergence and the bulk of the egg-laying seems to be completed within two or three consecutive days. The egg-laying capacity has been found to vary from 226 to 868 eggs. The egg period lasts from eight to ten days after which the tiny larvæ hatch out. The newly hatched lervæ is about 1 mm. iength, dirty white in colour with an yellowish head and is exceedingly active in its movements. It resembles a beetle grub in its activity and the prominent thoracic legs. Soon after hatching the larvæ scatter about and seek favourable spots for entry into the combs which are generally the septa between two cells. The first indication of the entry of the larva is the presence of small masses of minute particles of wax outside the

bore holes; but this powdery matter is promptly removed by the bees. The young larvæ very soon reach the central partition between the two sets of cells and begin to tunnel in different directions, feeding on the combs all the way and profusely lining the galleries with a silken material. It is difficult to detect the presence of the caeerpillar inside at the initial stages of attack except by a trained eye, but within a week the tell-tale external indications are exhibited by the prominent webbing over the cells. As the process of destruction advances the entire comb is eaten away and only a mass of webbing is left behind with traces of the old comb here and there. The larval period extends for about a month and the full-grown caterpillar is creamy white, stout, cylindrical, smooth and about an inch in length. It is also active in its movements but not so quick as the young ones.

Feeding habits of the larvæ.—As there was some controversy regarding the actual food of these larvæ, the results of the trials made at Coimbatore may be of some interest. Caterpillars of uniform length of 1 cm. were selected and fed separately on the following material in two different sets, the first one consisting of pure wax and combs under different conditions, and the second with pure pollen and a few combinations along with it. In the first set, the larvæ were fed separately on (1) shavings of wax, (2) foundation combs, (3) fresh combs without any lining of propolis, (4) old combs lined with plenty of propolis, (5) old combs from which only the wax had been removed, and (6) old combs with plenty of pollen and honey stocked by the bees. Out of these the first three were not at all relished by the caterpillars, as they simply nibbled the surface, eating very little and gradually shrunk in size, until they died of starvation. Further the characteristic webbing which is a prominent feature of these worms was absent. The reason for this is quite obvious since pure wax which consists mostly of Myricil palmitate, free Cerotic acid and hydrocarbons, has very little food value. The development and webbing activities of the caterpillars on the other three material were quite satisfactory and the progress of the let fed on old combs with pollen was particularly good. It is, therefore. clear that the normal food of the wax-moth larvæ is the honeycomb with plenty of the dark lining material consisting mostly of propolis, and that the inclusion of the pollen stored by the bees serves only as an extra delicacy. The lining material which contained all the other components of the comb except the wax was found to contain all the necessary food ingredients as shown in Statement I. The worms have not, so far, been noted to feed either on the brood or the honey. The second set of trials indicated that these larvæ are also capable of thriving on certain combinations with pollen. The following material were used for the experiments: (1) pollen collected and stored by the bees in the cells, (2) maize pollen collected from the field, (3) pollen mixed with water, (4) pollen mixed with honey, (5) pollen mixed with sugar and (6) pollen mixed with equal quantities of dextrose

and levulose. The progress of the worms fed on the pollen collected by the bees themselves was particularly good and the caterpillars did not thrive on pure maize pollen. The development of the caterpillars was normal in all the other cases. The difference in the development in both the tests is clearly visible only when the young caterpillars are taken for the experiments, as older larvæ somehow manage to pupate and emerge as adults irrespective of the quality of food given.

STATEMENT I.

	Amount. PER CENT.
1 Moisture	8·41
2 Ash	6·15
3 Crude Proteids	17·60
4 Alchohol extractives	29·73
5 Crude fibre	23·36
6 Carbohydrates (by diff)	14·75
Total ..	100·00

(Albuminoid nitrogen. 15·40)
(Insolubles .. .. 0·26)

The sample seems to contain a good amount of food materials.
(Analysis by the Government Agricultural Chemist, Lawley Road P.O.)

The pupa.—The full grown caterpillar seeks out a sheltered corner and spins a white silken cocoon for itself prior to pupation. The cocoons are generally found in numbers either amidst the ruined combs or in the sheltered corners of the hive. In cases, where combs of the rock bee are attacked they invariably stick out of the comb-surface like small wooden pegs. The pupal period lasts for about eight days after which the moth emerges and the life-cycle is repeated. Of the two sexes the males appear to be endowed with a longer lease of life. In captivity they are found to live from 18 to 27 days and the females from 6 to 10 days.

Control measures.—The nocturnal habits of the moths and their peculiar egg-laying habits combined with the obscurity of the caterpillars in the initial stages of attack render early detection of the infestation and its subsequent control rather difficult. But with the experience gained so far, the control of this serious pest has been rendered comparatively easy. The quintessence of success lies in tackling the pest in its egg stage. As already mentioned, the moths lay their eggs in the cracks, crevices and other inaccessible parts of the hivebody. Frequent examinations of the interspaces between the brood-chamber, super and the top during the season—July to October---would reveal the presence of the small, pinkish egg masses, and these can be summarily crushed then and there. There is also the possibility of the eggs

having been laid inside the spaces between the joints of the hive which could not be located without dismantling the hive to pieces. If there is a suspicion to this effect, the frames with the bees can be transferred to another hive-body and the old one kept away for about a week until all the caterpillars hatch out and perish for want of food. Such frequent examinations and changes of the hive-body during the pest season would practically eliminate the chances of infection from the eggs. If the infestation is neglected in the earlier stages, the control then becomes more difficult. The following hints may, however, serve more as palliatives. In severely infested colonies, numbers of the caterpillars and sometimes pupæ also, may be found on the floor-board and in the inter-spaces between the frames. These portions should be examined periodically and the stages destroyed. In cases where the caterpillars are inside the combs, they should be taken out and destroyed, though it may involve in the destruction of a little brood. There is also a belief that strong colonies are able to ward off the infestation because of the large number of bees guarding the entrance during nights. This does not, however, prove to be true in actual experience since the minute caterpillars are capable of entering any hive and infesting the combs. But it has to be admitted that such colonies, though infested, remain in the hive for a longer time, probably till the entire brood emerges while weaker stocks abscond soon after the infestation. It may, therefore, be worth the trouble to keep up the strength by the methods mentioned in Chapter X. Other prophylactic methods such as general cleanliness, careful destruction of the waste combs, etc., would obviate the breeding of the pest in nature. The trouble and care of the bee-keeper do not cease with his attention to the hive. Spare combs taken from colonies dwindling in strength and kept for the next season's use are equally subject to the infestation unless they are carefully stored. The cheapest and simplest method of preserving these combs, wax-moth-proof, is to store them air-tight in a mud pot and seal the lid with cow-dung. The addition of one or two naphthalene balls will add to the safety, but care should be taken to aerate these combs and thus eliminate the smell of naphthalene before they are given to the bees. In spite of these precautions, it is common to find some of the combs with plenty of the caterpillars. This may be due either to careless packing or the presence of a few eggs or young caterpillars in the combs themselves prior to packing. One of the common methods advocated in the Western countries to eliminate these worms is to fumigate the infested combs with chemicals like Carbon-bi-sulphide, Sulphur, etc., a process which is likely to be costly and sometimes dangerous too. An easier method, involving lesser trouble and no expense, was devised at Coimbatore. The infested combs are exposed to the morning sun, when the temperature does not exceed 95°—100° F in the open. The worms, being unable to bear the heat and the glare, wriggle out and collect themselves under the comb from where they could be

easily collected and destroyed. It is likely that the combs may get a little soft at this temperature but they regain their original rigidity soon after they are kept in a cool place. The silken webbing woven by the larvae can be removed easily with a brush and the small holes and other petty damages are promptly repaired by the bees, when the combs are given to them.

The treatment, exceedingly simple and cheap as it is, can also be effected by artificial means, which may be useful in the temperate regions where the luxury of a strong sun is denied by Nature. The principle underlying the method is to simulate the natural conditions in an improvised hot-chamber. The "modus" followed is described below. Infested combs were kept flat inside an incubator with its temperature raised and maintained between 113° and 118° F. A strong light was provided at the top with the help of an electric bulb of 25 watts capacity. After about 15 minutes the worms wriggled out and collected themselves below exactly as in the case of the sun treatment. Exposure of the infested combs kept both flat and vertical to mere heat without the light did not produce the desired effect. It is, therefore, clear that a certain amount of heat and light are required to eliminate the larvae from the combs, the degree of heat under artificial conditions being slightly higher. This may probably be due to the higher intrinsic quality of sun's rays, both in regard to the heat as well as the light. The method may not be necessary for the tropics, but offers some scope in the temperate regions. Any special chambers or hot-houses already existing for other purposes can be adapted for this treatment. The outstanding feature of this method lies in its extreme simplicity, leaving aside the question of the expenditure and the possible risk involved in the use of the chemicals and fumigants.

(2) *The black ant* (*Fig.* 21).—These ants live in underground colonies, which are conspicuous by the small mounds of earth around the bore-holes. They are fond of establishing themselves near dwelling houses and under trees. Numbers of the ant-hills spring up almost every-where after the rains and the ants are particularly troublesome during this period. Apart from attacking anything that is consumable, they turn their attention to bee-colonies also. They usually loiter about the hive in numbers waiting for a chance to grab an unwary bee. Weak colonies are invaded wholesale; and everything including bees, grubs, pupæ, honey, pollen, etc., is devoured. But in stronger colonies the damage is not so severe, though a good number of bees are snapped away. The bees do their best to frighten and drive them away, but to no purpose. Even when gripped between the powerful jaws of the enemy, the bee tries to sting it, but invariably the thief is the victor. Apart from causing damage, they also rob away a good quantity of the nectar from flowers, which would otherwise have been useful to the bees.

Control measures.—The best method of tackling these ants is to destroy their colonies by dropping a small quantity of Calcium cyanide into the ant-holes. The chemical evolves a poisonous gas which kills the ants. Care should, however, be exercised in handling the chemical as the gas is highly poisonous to human beings as well as to other animals. Kerosene oil or tar can be poured into the holes to drive the inmates away. The simplest method would be to keep the hives on stands provided with ant-pans. Water, with a few drops of kerosene should always be allowed to stand in these pans.

(3) *The bee-hunter wasp.*—This is generally found only on the hills and is a special enemy of the hill variety of the Indian bee.

(4) *The smaller bee-hunter wasp* (*Fig.* 21).—This is a small wasp about $1\frac{1}{4}$ cm. long, dark in colour, with transverse yellowish white stripes on the abdomen and thorax. It has been noted as a predator on bees at Tiruchengode, Coimbatore and Ponnani and is capable of doing considerable damage. It is very active in its habits and makes underground tunnels in shady bunds and corners nearby with a number of separate compartments to stock its prey which serves as food for its young ones. It waits near the entrance of bee-colonies and being endowed with powers of quick flight, is able to snatch and take away bees to its nests. Each wasp was found capable of collecting about 20 bees in a day and the time of hunting was limited to bright mornings and afternoons. Leaving aside the loss of bees which is fairly serious, the colonies in infested localities, seldom work properly since the attention of the bees is diverted more towards their self-protection. Eggs are laid by the female wasp between the head and thorax of the prey, one egg being laid for each group of 4 or 5 bees in a compartment. The grub hatches out on the second day and feeds on all the bees in about 5 days, by which time it attains the full growth. The pupation takes place inside an earthen cocoon made by the grub itself from which the adult emerges. Control of the pest can be effected by hand-netting the adults and by digging out their breeding spots.

(5) *The yellow banded hornet* (*Figs.* 21 *and* 22).—These hornets are also social insects, like bees, ants, etc. They build combs out of a paper-like substance inside enclosed spaces like burrows of trees, cracks in walls, etc. They are predaceous in habits. The adults catch their prey, macerate them with their mouth-parts and feed their young with the juice. Sometimes they visit bee-colonies, wait at the entrance or even enter the hives and carry away numbers of the bees. Occasionally the damage caused is serious. The wasps can be easily caught with a hand-net and destroyed. A better method would be to hunt out their nests and smoke them wholesale during nights or apply Calcium cyanide.

(6) *The death's head moth* (*Fig.* 21).—These moths can hardly be called enemies of the honey-bee, as they only drink a little of the honey stored in the combs. They emerge in numbers after heavy rains and can sometimes be seen struggling to enter the hives late

in the evenings, in spite of the narrow opening and the very strong but ineffective protest by the bees, their scaly and slippery coating, serving as an efficient protection against the stings. Having crept in, the moth drinks a little honey, but seldom comes out alive as the bees either suffocate or sting it to death in some vulnerable spot. Dead specimens may be commonly seen either on the floor-board or sometimes pasted on to the combs with wax. In a solitary instance over 70 moths were found dead inside the hollow of a wild colony (Fig. 23).

(7) *The lesser wax-moth* (*Fig.* 21).—It is a minor pest of combs. Some consider it only as a scavenger after an attack of *Galleria mellonella*. At Coimbatore, it is mostly seen feeding on the debris gathered on the floor-board, but occasionally causes some minor damage to stored combs also. In captivity, the moth lays its egg in groups generally hidden under the broken fringes of the combs or in cracks and crevices of the receptacle. The eggs are roughly spherical in shape, less than 1 mm. in size and pale white in colour. The capacity for egg-laying by a female ranges from 73 to 186. The egg period lasts from two to four days. The newly hatched larva is fairly active about 2 mm. in length, lightly pubescent with a coppery brown head capsule. It burrows into the combs only superficially and feeds on them, constructing the characteristic silken tunnel covered with their excreta. The larval period lasts from 34 to 38 days after which the caterpillar constructs a silken cocoon completely covered with its excrement and pupates inside it. The cocoon is generally found amidst the debris and in rare cases on the sides of the receptacle also. The pupal period lasts from 5 to 12 days after which the adults emerge. The longevity of the moths is not high, the maximum being eight days.

The caterpillars of *Galleria* are bigger in size and stouter in build than those of *Achroia*. Their feeding habits also vary. Caterpillars of *Galleria* take their position at the central partition of the comb and feed voraciously on them. The infestation is revealed by the presence of a whitish silken webbing over the cells. Caterpillars of the smaller moth feed mostly on the surface hiding themselves inside the silken galleries. The latter hang out in shreds and are completely covered by the dark pellets of excreta that adhere to it, giving it an almost brownish or a dark colour.

Control measures.—To a great extent, the Braconid parasite *Apanteles gallerae* keeps these larvæ in check. But as the caterpillars are generally found on the floor-board, frequent cleaning of the same would keep the hives free from this pest. Infested combs can be saved as suggested in the case of the wax-moth caterpillars.

(8) *The wax-beetle* (*Fig.* 21).—This is often found inside the hives but it has not, so far, been found to cause any appreciable damage to bee-colonies. This beetle is a dark, sluggish creature and feigns death when disturbed. The adults and grubs are generally found hiding in the crevices of the base-board, feeding on the debris

accumulated there. In weak colonies they may nibble a few bits of the combs. The female lays its eggs in the crevices of the hive and the grubs measuring about 2 mm. in length hatch out in four days. The young grubs scatter themselves over the floor-board feeding on the particles of comb, pollen, etc. The grub stage lasts for about two or three months and the full-grown grub is about 11 mm. in length. The pupae are naked from which the adult beetle emerges in six days. The beetles have been found to live up to six months. No special precautionary measures are necessary except for an occasional cleaning of the floor-board and the crevices of the hive.

(9) One or two species of cockroaches often take their abode inside weak colonies and nibble away small bits of the combs. Though the damage is negligible they render the inside of the hives very insanitary by the foul smelling excreta. The egg cases also when crushed give out an equally bad smell.

(10) Occasionally a leaf-cutter bee (*Megachile disjuncta, F.*) enters weak colonies and gnaws away bits of the exposed combs.

(11) A few species of small ants are sometimes found inside the hive without doing any appreciable harm.

(12) *Blood-suckers and lizards.*—These often lurk about the entrance of the hive and steal away stray bees that come within their reach. The damage done by these is almost negligible and their control easy, since they can be killed without much trouble.

(13) *Bee-catching birds.*—The Indian drongo and the green bee-eater have the habit of catching bees at flight and devouring them.

Besides these, robber flies, dragon flies, frogs, toads, etc., have been found to feed on bees. In the jungles bears are often reported to rip open tree trunks containing bee-colonies and devour the combs.

CHAPTER VII.

The Artificial Hive.

> **" Whether thou build the palace of thy bees**
> **With twisted osiers or with barks of trees**
> **Make but a narrow mouth; for, as the cold**
> **Congeals into a lump the liquid gold."**
>
> —Virgil IV Georgics.

An artificial hive is a miniature house designed for accommodating bee-colonies. The hive in its simplest form, consists of a rectangular wooden box, open at the top and bottom with a shallow

cut at the lower side of the front plank to serve as the entrance. A few movable frames are fitted into this box to support the combs. The lower side of the box rests on a piece of plank which is slightly broader and a few inches longer than the hive-body. The portion under the brood-chamber serves as the floor-board and the projecting end in front as the alighting space. The top is a movable roof-like contrivance. The fundamental principles in designing the artificial hive are the movability of the frames and the provision of the requisite space between them. The latter is popularly known as 'bee-space' and has been arrived at by measuring the distance between two combs in wild colonies of A. indica and simulating the conditions in the hive. This space should be 1/4 inch, which is just enough for two bees to move about conveniently between the combs with their backs together. Any error in spacing is likely to encourage irregular comb-construction. The width of the top-bar of the brood-frame should be just that of the brood-comb, which is 7/8th inch in the case of the Indian bee.

Different types of hives.—Numerous patterns such as the Standard and Well hives, the Kerosene box hive, the Langstroth hive, etc., are being advocated and used in different parts of the country. But in South India, the only successful and popular model is the one designed by Rev. Fr. Newton and the Madras Agricultural Department advocates only this hive for the present. There is, however, a note of scepticism regarding the size of this hive. Trials have been and are still being made to evolve a better type and until definite results are achieved, it is not advisable to recommend any other pattern.

The Newton Hive (*Fig.* 24).—This is the popular type having the usual compliment of the different parts such as the base-board, the brood-chamber, super, and the top. The brood-chamber and the super are made to hold seven frames in each. The number for the brood-chamber has been fixed by calculating the average brood-area present in strong bee-colonies and the arrangement has been found to be quite satisfactory under South Indian conditions. Queens of ordinary prolificity have been found capable of laying enough eggs to rear brood only over five combs and that too during the favourable season. The two side-combs are invariably used for storing pollen and honey. Along the top of the front and rear planks of the brood-chamber a groove of about $\frac{1}{4}$ inch in depth is necessary along the inner sides to rest the frames and a clearance of about one-fourth of an inch is provided between the lower extremity of the frames and the floor-board. The front-plank of this box is provided with an opening of $3\frac{1}{2}$ inches by 3/8 inch at its lower side to serve as entrance. The following are the measurements of the brood frames:—

	INCHES.
Breadth of top-bar	7/8
Total length of the top-bar	10
Thickness of top-bar	1/8
Inner length of frame	$8\frac{1}{4}$

	INCHES
Inner height of frame	$5\frac{3}{4}$
Total height	6
Height of side-bar	$5\frac{3}{4}$
Width of side-bar at the top	$1\frac{1}{8}$
Width of side-bar at bottom	$\frac{1}{2}$

An extension of one-eighth inch is given on either side of the side-bar and a clearance of $\frac{1}{4}$ inch is thus effected when two frames are kept side by side. Though the standard number of seven frames has been found to be enough, the hive-body and the super may be made bigger to accommodate one or two additional frames in exceptionally favourable localities. The super is exactly of the same length and breadth of the brood-chamber but its height is only 3 and 1/8 inches. Similarly the dimensions of the super-frame are the same as those of the brood-frame, but the internal height is $2\frac{1}{2}$ inches. The top, as shown in the figure has two sloping planks on either side. An opening of $3\frac{1}{2}$ inches square, fitted with wire-gauze, is made on the lower ceiling plank to provide ventilation but this arrangement does not seem to be a real necessity as the bees generally paste the meshes with wax. The two holes on the front and rear planks of the top provide the necessary draught. Care should be taken to provide a clearance of about $\frac{1}{4}$ inch between the ceiling plank and the frames below. The floor-board is a mere plank slightly wider and 4 inches longer than the brood-chamber with beadings on three sides into which the hive-body fits in tightly. The extension in the front serves as the alighting-board. One or two coats of a good paint would protect the hive from weathering agencies and prevent the consequent warping but no definite information is available regarding the particular colour which would be acceptable to the Indian bee. The European bee is reported to prefer yellow to white and then dark blue. Red is disliked and pale blue, green and pink are relatively neutral. Materlink, the famous author and bee-keeper, states that pale blue colour is liked by bees. T.B. Fletcher mentions in Pusa Bulletin No. 46, that bees do not like black objects. The Madras Agricultural Department use a pale blue paint for the hives made and supplied by them. A piece of plank with the same dimensions as the brood-frame would answer the purpose of the dummy-board quite well. The use of this contrivance will be found necessary in the case of weak colonies to provide the necessary compactness.

Importance of keeping bees in hives.—The advantages of keeping bees in modern hives lie in the conservation of the combs and consequently the energy, time as well as of the honey stored by the bees. Much stress is unnecessary here on the importance of these aspects. Conservation of the comb is one of the fundamentals of scientific bee-keeping for the reason that the combs are made of wax, which is again a secretion of the bees. The theory is that they have to consume 15 lb. of honey for producing one pound

of wax. Under primitive methods, the honey combs, very often with the brood are cut and the honey squeezed out after smoking the colony wholesale. This method of extraction is destructive because enormous numbers of the bees and their young ones are sacrificed and the colony is deprived of its combs, which could be constructed again only at considerable expense of honey. Apart from this almost criminal destruction of life, the method is uneconomical since by the time the bees recover from the shock of disturbance and construct fresh combs and store honey again, the honey season might be over. In the artificial hive, the super-frames containing honey can be taken out without upsetting the routine of the colony, the honey extracted by the machine and the combs returned in tact to the bees for further storing. It is, therefore, clear that in the case of the pot-hive it may not be possible to have more than one extraction, leaving aside the unhygienic process and destruction of life, whereas in the present day hive, honey can be extracted as quickly as it is gathered and sealed. The movability of each frame along with the comb facilitates an easy examination and scrutiny of the conditions inside the hive without in any way injuring the combs or inconveniencing the bees. Such an examination is necessary to know the progress of the colony regarding brood-rearing, queen-cell construction, etc., and it is only after knowing the actual condition inside that the bee-keeper will be able to furnish the necessary facilities for the proper maintenance of the colony. In short a well-designed hive affords the necessary convenience and provision for the bees to rear their brood and store honey separately, besides the protection rendered against adverse weather conditions and natural enemies.

CHAPTER VIII.

Hiving a Wild Colony.

"He who with health would live at ease
Should cultivate both fruit and bees."

In the Western countries where bee-keeping has been practised for a long time, bees, standard hives, and other accessories are available for purchase like any other commodity. In India, where the industry is still viewed more as a curiosity, any enthusiast who wants to start an Apiary has to make the hives first, capture wild colonies and domesticate them.* The latter are commonly found in burrows of trees, crevices of walls, etc. The best way to locate them is to observe the likely places during bright mornings, when numbers of these busy creatures can be seen going in and out of the burrow. Having located the colony in a convenient place, the subsequent process of hiving consists of transferring it wholesale along with the combs, bees, and the queen to the artificial

* A few firms have, of late, taken up the manufacture of apicultural requisites.

hive. A bright sunny day should be selected for this work and the necessary outfit required is an artificial hive, a small axe and a chisel for widening the entrance, a good supply of old rags for smoking, a small quantity of plantain fibre for fixing the combs, a table-knife, a pair of scissors and lastly a glass tube 3 inches by 1 inch open at one end; or an empty match box for capturing the queen. A few whiffs of smoke should first be blown into the burrow in order to quieten the bees, but this should be judiciously regulated. Too much of it either demoralises the colony to such an extent that the whole population moves away to some of the inaccessible crevices rendering their capture difficult or makes the bees too cross for handling. The entrance of the burrow has then to be widened so as to allow both the hands inside freely for removing the combs. They are generally attached to the top of the hollow, and a clean cut with the knife along the upper border would facilitate their easy removal, without any damage. They should be removed along with the maximum number of bees adhering to them and this would be possible only by a very gentle and careful handling. Each comb should be examined for its contents. Good sized, undamaged pieces, having plenty of worker-brood should be selected and carefully cut to fit into the frame of the hive. They should then be fixed with plantain fibre as shown in Figs. 25 and 26 and promptly kept inside the hive so as to avoid exposure to the weather. After all the available brood combs have been fixed, those containing pollen and honey may be fixed and kept at the sides to supply the necessary food for the bees until they get accustomed to the new locality. Bits of combs should not be allowed inside the hollow, as they invariably attract the bees. The removal and fixing of the combs are easy when compared with the task of getting all the bees inside the hive. A few mechanical methods such as shaking the whole cluster of bees, scooping with the hand and transferring them to the hive are advocated. But they are neither practicable in all cases nor are they infallible. But the process can be simplified if the work is adjusted in accordance with the habits of bees. It has already been mentioned that bees have an extraordinary attachment for their queen and prefer to be in her company under any circumstances. This habit can be taken advantage of for enticing the whole population into the hive by securing the queen and keeping her inside the hive as a bait. A careful eye should, therefore, be kept for her while removing combs. If she is spotted, she should be immediately captured in the glass tube along with a few workers and its mouth covered with a piece of mosquito netting. In the absence of the tube, the empty match box may be used but care should be taken to keep the lid slightly open for providing ventilation for the captive, as well as for helping the bees to smell out their queen. The capture can be effected by inverting the tube over the queen and then quickly closing the entrance when she is half way inside. But care should be taken not to injure her during the process. Once the queen is secured the preliminary part of the

hiving may be said to be over. All stray bits of comb lying scattered about, as well as those left inside the burrow, should be removed. The receptacle with the queen is now placed on the top of the frames as shown in Fig. 27. Ordinarily, at least a quarter of the population should now be inside the hive, covering the combs. The rest of the bees in their original home, having been deprived of all that is dear to them, scatter about and begin to search for their queen. A little smoke blown in at this critical moment adds to the confusion and the whole population flies out, making wide circular flights, which is often characteristic when bees are trying to locate the queen. By about this time a few of the workers may be seen clinging round the mouth of the receptacle, trying to get near the captive. Within a very short time, the location of the queen is communicated to the rest of the bees in some mysterious way and this is followed by a wholesale rush to the hive, and the bees, very probably being under the impression that she would be in their midst very soon, go down to the combs below and settle on them. When the majority have entered the box, a super without frames may be placed over the hive, the queen liberated and the hive closed. After she crawls out below, the super and the cage may be removed and the top put on. The last of the stragglers now arrive at their new home and being unaccustomed to the entrance, they attempt to force in through all the slits and openings in the body of the hive. These can be directed to the entrance by gently shoving them with a piece of cardboard. If it is desired to shift the hive elsewhere, the entrance should be plugged with a piece of wire-gauze and opened out a few minutes after arrival at the destination. Since some colonies are situated in inaccessible places, a hiving box (Fig. 28) about one foot high, 15 inches long, and 8 inches broad, provided with a 18 mesh wire-gauze on the sides and with a sliding door at the front, would be more handy. The whole family of the bees with the combs is first captured into this box and transferred to the hive later. This transferring should, as far as possible, be done beyond the hearing of settled colonies, if any, since the buzzing noise created by the flight of hundreds of bees, might unnecessarily alarm the inmates of the established hives. The confusion sometimes ends in disastrous results either in the bolting away of the settled colonies or the wholesale entry of the new captives into one of the settled hives. New colonies should be placed a little away from the other hives and gradually moved nearer, if necessary. Otherwise the new comers on their reconnoitering flight the next morning, often mistake the neighbouring hive for their own and enter it which would lead to fighting and loss of life. The hiving described above is in its simplest form but the practical execution of it is somewhat difficult. The location of the queen might not be easy, since the whole population at the first disturbance by smoking finds a safe retreat in some of the inaccessible crevices so common in natural cavities. Under such circumstances, breaking open the burrow and securing the queen would be ideal but it may not be possible in most

cases. The only other alternative is to scoop out and transfer handfuls of the clustered masses of bees that would be formed inside the hollow. This is not a sure method, but there is always a probability of getting the queen along with the cluster, since such bag-like groups are formed mostly around her. It is also a matter of common experience that in the absence of the queen, the bees spread themselves out and are very vicious in temper. Under these circumstances, the other alternative would be to drive out all the bees by liberal smoking, having a careful eye on the entrance. In case the queen escapes, she settles somewhere and the whole population gathers immediately round her. The entire group can either be shaken or swept into the hive as described under 'hiving swarms'. Colonies are also sometimes found in old pots thrown under shady hedges, toddy pots on coconut trees, etc. If one is lucky enough to pitch upon these, the hiving becomes comparatively easy. The pot is taken out and after applying a little smoke, the combs are pulled out and fixed to the frames. Then the whole mass of the bees can be either slowly driven or shaken into the hive. Hiving colonies of the Hill bees can be accomplished on the same principle, but a little more patience and skill are required as they are not so easily amenable to handling. Little or no smoke should be used since the infuriated bees come out in hundreds and render work impossible by hovering about the face stinging severely and sometimes even chasing passers-by and domestic animals to long distances. In the case of the bee of the plains, they do not come out in such large numbers nor are they able to fly for such a long time, probably on account of the warmer climate. Further, they show a tendency to cling to their brood-combs closer at any sign of impending danger, while the hill bees are so shy that they desert their combs and scuttle away to different corners at the slightest disturbance. The location of the queen is difficult as she is as dark as the bees in colour and equally shy in habits. In most cases, these colonies have to be captured by transferring handfuls of bees.

Hiving by any one of the methods mentioned above must generally be a success, but in some cases the queen escapes detection. Nothing is lost even under such circumstances as the bees invariably rear a fresh queen out of the existing fertilized eggs, provided the seasonal and pasturage conditions are satisfactory. In such cases, the queen grubs are reared either in the comb itself by widening the existing cells or by constructing a few queen-cells along the lower border of the combs and transporting the fertilized eggs or young grubs to them. The new queen will emerge in due course and the other queen-cells may be removed to avoid the possibility of the issue of swarms. Since the process of locating wild colonies is rather tedious and difficult for a beginner, Father Newton advocates the use of decoy hives based on the same principle as the empty pots used in some parts of Mysore, Coorg, Vizagaptam, etc. These consist of pieces of hollowed out palmyra trunks with both the sides closed with planks. A few small

openings are made on one of these planks to permit the bees to go in and come out. The inner surface of these receptacles is smeared with a little wax in order to attract the bees. During the swarming season, several such contrivances are made and fixed at convenient places such as branches of trees, corners of buildings, etc. Eventually some of these are occupied by swarms. These are left alone for a few weeks until the bees construct combs and rear brood. The tenanted logs are then brought down, one of the sides opened and the colonies transferred to the artificial hives.

During the process of hiving, some bees are likely to be either killed or lost and the population will naturally be reduced. It is, therefore, advisable to give only just the number of combs that could be completely covered by the bees and discard the rest. Apart from the technique used, the success of hiving such wild colonies depends, a good deal, on the season during which the hiving is done. If colonies are captured during the good breeding season when there are plenty of eggs, young brood and food-supplies in the combs, the bees seem to take scarcely any notice of the change. The necessity to provide food for their young diverts the attention of the workers towards the more important duties of foraging and by the time they reach full growth, the bees get used to the new surroundings and settle down to work. If the hiving is done during the lean season, when there is very little food and brood in the comb and much less pasturage in the field, the bees scarcely stick on to the hive. Further, wild colonies are generally infested by the wax-moth, during such adverse seasons. The drastic change of conditions and the consequent dislocation of work, only aid the pest to get the upper hand which accelerates the tendency of the bees to swarm away.

Behaviour and care of newly caught colonies.—The beginner who should naturally be anxious to know the results of his attempts, may be almost sure of his success, if a number of bees return with their tiny loads of pollen, as the collection of this material indicates that the young ones are being looked after. Under ordinary circumstances, the bees start their work almost immediately by bringing out dead grubs, etc. The next morning they reconnoitre the new surroundings and in two or three days, begin to gather pollen and honey. A little feeding with sugar syrup or dilute honey (see artificial feeding) would accelerate the working of the colony and induce the bees to start the normal routine. Within a fortnight after the capture, the bees will cut and bring out bits of plantain fibre with which the combs were fixed, but sometimes they do this without properly attaching the combs. In such cases, they drop down and will be found glued irregularly to the others or to the sides of the hive. These should be cut out and fixed to the frames again. After all the combs have been properly pasted to the frames, the plantain fibres may be cut and taken away if the bees had not done it themselves. It is better not to meddle with the fresh captures for a time, except for cleaning the floor-board once in two or three days. The behaviour detailed above represents

the normal features, but one has to be prepared to face his usual share of failures and disappointments. In some cases, even the apparent attention of the bees to the normal activities cannot be taken as a sure indication of their having settled down in the hive. The more reliable index would be the prolific egg-laying of the queen and subsequent brood-rearing.

The disinclination of the bees to take to their new home is indicated by the inactivity of the queen, a general slackness and lack of interest in the normal bee-activity. Very little or no field work is done. The bees inside show a reluctance to cover the combs properly and may be found clustering in small isolated groups. Before attributing this cross behaviour to the sluggishness of the bees or the fault of the queen, other factors such as improper and inconvenient location of the hive, presence of enemies like the wax-moth, should be first eliminated. Steps may then be taken to stimulate the queen's activities. Granting that the weather, pasturage, and hive conditions are satisfactory, the queen may be induced to lay eggs by providing a brood-comb having plenty of eggs and grubs from another colony. The presence of the young probably excites the maternal instincts of the bees and stimulates the queen's activities. But in spite of all these ingenuities, we have sometimes to experience failures, since some colonies show a tendency to desert even after all this trouble. Here again advantage may be taken of the mutual affinity between the queen and workers and prevent the former from following the bees when they bolt. Fixing a drone-trap or a piese of queen-excluder at the entrance would effect this, as the narrow slits confine the queen to the hive, while allowing the workers to carry on their usual foraging activities. Bees do not generally desert without their queen and her continued imprisonment may, in most cases, compel them to settle down ultimately in the hives. Even here, success cannot be assured, since in rare instances, the bees kill the queen as well as all the brood and then abscond. Colonies deserting for the first time generally settle somewhere nearby and these can be re-hived (as in " Hiving swarns "), but as they invariably exhibit a tendency to swarm out again, it is better to unite them with settled colonies (see Uniting).

The above instructions are of a general nature. The novice has to make a careful and intelligent study of the habits of the bees and use his experience according to the circumstances. He is likely to get disappointed when many of his colonies desert for no apparent reason. The only advice that can be given is to capture as many colonies as possible and try to maintain them all. Even under ordinary circumstances, a fair percentage of the hivings must be successful. Once a few colonies get established in a locality, it looks as if a bee-atmosphere is established there and subsequent captures do not show any tendency to bolt away. It is not always possible to explain this, but it has been the writer's experience that bees require company of their own kind in a new locality before they establish themselves.

CHAPTER IX.

PASTURAGE.

"Brush'd from each anther's crown, the mealy gold
With morning dew and light-fang'd artists would,
Fill with the goodful load their hollow'd thigh
And to their nurslings bring the rich supply."

—DR. JOHN EVANS.

Pollen and nectar are generally found in flowers and bees collect and store them for their food. The plants which are visited by bees are spoken of as bee-pasturage. The success or failure of bee-keeping primarily rests on the availability of these bee-foods in the vicinity.

Pollen is the fine powdery material found in most flowers. It is contained in special chambers called "anthers" and the latter are borne at the end of stalks known as "stamens". The colour, size and shape of these pollen grains as well as the quantity available varies according to the species of the plant. The presence of this material is more essential to plant life, as it provides the male element necessary for fertilization. It is equally essential for successful bee-keeping as it forms a complete nitrogenous food for the bees by virtue of its high protein contents. The chemical composition of two samples is furnished below :—

STATEMENT II.

Analysis of Pollen.

Heads of Analysis.	Cholam Pollen. PER CENT.	Maize Pollen. PER CENT.
1 Moisture (over H_2SO_4 under reduced pressure)	46·34	52·88
2 Ash	1·86	1·38
3 Crude proteins	11·57	10·00
4 Ether extractives (Petroleum ether).	1·35	2·24
5 Crude fibre	3·74	2·99
6 Carbohydrates (by difference) ..	35·14	30·51

Both the samples were found to contain fair amounts of food material.

(Analysis by the Government Agricultural Chemist, Agricultural College, Coimbatore.)

Nectar is the raw material from which honey is elaborated by bees. It is a thin watery secretion found in a special set of glands known as "nectaries". They are generally situated at the base of flowers and sometimes in the leaves and nodes of plants. The presence of the sweet fluid is also a provision of Nature to attract insects to the flower and ensure its cross-pollination. The secretion of nectar is not a common feature for the whole vegetable kingdom, since a good many varieties of plants do not possess nectaries and even if present, they may not function in some cases.

The quantity and the concentration of the fluid secreted appear to be controlled by a variety of factors such as previous rainfall, relative humidity, temperature, seasons variations, altitude, physical and chemical composition of the soil, prevalence of high winds, etc. The problem is of a complex nature and considerable work is yet to be done under South Indian conditions.

The bee-pasturage crops at Coimbatore, as well as of the districts of this Presidency were studied as opportunities occurred and a list of these plants along with their months of flowering is given below. It is, by no means, complete and further work is necessary to make it more comprehensive.

STATEMENT III.

Months.	Pollen-yielding plants in flower.	Nectar-yielding plants in flower.
January	Balsams (*Impatiens balsamina*).	Agathi (*Sesbania grandiflora*).
	Cholam (*Sorghum vulgare*).	Cambodia cotton (*Gossypium sp*).
	Cucurbitaceous plants (*Cucurbitaceae*).	Cucurbitaceous plants (*Cucurbitaceae*).
	Cumbu (*Pennisetum typhoides*).	*Polygonum glabrum*.
	Maize (*Zea mays*).	Sunflower *Helianthus annuus*).
	Peru (*Ailanthus excelsa*).	
	Sunflower (*Helianthus annuus*).	
	Sweet potato (*Ipomaea batatas*).	
	Tridax procumbens.	
	Zinnia.	
February ..	Cumbu (*Pennisetum typhoides*).	Cambodia cotton (*Gossypium sp*).
	Indian Elm (*Holoptelea integrifolia*).	Chicory (*Cichorium intybus*).
	Maize (*Zea mays*).	Cucurbitaceous plants (*Cucurbitaceae*).
	Peltophorum ferrugineum.	Drumstick tree (*Moringa pterygosperma*).
		Karunochi (*Justicia gendarussa*).
		Kapok (*Eriodendron anfractuosum*).
		Karunganni cotton *Gossypium sp*).
		Ruellia prostrata.
		Sour lime (*Citrus medica*).
March	Alangi (*Alangium salvifolium*).	Alangi (*Alangium salvifolium*).
	Castanospermum australe.	Cambodia cotton (*Gossypium sp*).
	Maize (*Zea Mays*).	*Castanospermum australe*.
	Nona (*Morinda tinctoria*).	*Gliricidia maculata*.
	Palmyra tree (*Borassus flabellifer*).	Kapok (*Eriodendron anfractuosum*).
	Peltophorum ferrugineum.	Kolingi (*Tephrosia purpurea*).
	Vadanarayan (*Delonix elata*).	Margosa (*Melia azadirachta*).
		Nona (*Morinda tinctoria*).
		Petrea volubilis L.
		Prosopis juliflora.
		Pungam (*Pongamia glabra*).
		Rain tree (*Enterolobium saman*).
		Wood-Apple (*Feronia elephantum*).

Months.	Pollen-yielding plants in flower.	Nectar yielding plants in flower.
April	Maize (*Zea mays*). *Peltophorum ferrugineum.*	*Albizzia lebbeck.* Curry leaf (*Murraya koenigii*). Maval:ngum (*Crataeva religiosa*). Rain tree (*Enterolobium saman*).
May	Cholam (*Sorghum vulgare*). Coconut (*Cocos nucifera*). Flame of the forest (*Delonix regia*).	Panni Vagai (*Dalbergia paniculata*). Tamarind (*Tamarindus indica*).
June	Babool (*Acacia arabica*). Cholam (*Sorghum vulgare*). *Cleome viscosa.* Coconut (*Cocos nucifera*). Cumbu (*Pennisetum typhoides*). *Euphorbia antiquorum.* Flame of the forest (*Delonix regia*). Guava (*Psidium guajava*). *Lagasca mollis.* Maize (*Zea mays*). Mandharai (*bauhinia hookeri*). Prickly-pear (*Opuntia dillenii*).	*Antigonon leptopus.* Drumstick tree (*Moringa pterygosperma*). Mandharai (*Bauhinia hookeri*). Snakeclimber (*Bauhinia anguina*). Tamarind (*Tamarindus indica*).
July	Babool (*Acacia arabica*). *Chionachne koenigii.* Cumbu (*Pennisetum typhoides*). *Eupatorium heteroclinium.* Flame of the forest (*Delonix regia*). Gingelly (*Sesamum indicum*). Maize (*Zea mays*). *Peltophorum ferrugineum.* Pirckly-pear (*Opuntia dillenii*).	*Chionachne koenigii.* Drumstick tree (*Moringa pterygosperma*). *Eupatorium heteroclinium.* Gingelly (*Sesamum indicum*). Tamarind (*Tamarindus indica*).
August	*Bidens pilosa.* Cumbu (*Pennisetum typhoides*). *Eupatorium heteroclinium.* Onions (*Allium cepa*). Pumpkin (*Cucurbita pepo*). Ragi (*Eleusine coracana*). Zinnia.	*Antigonon loptopus.* *Bidens pilosa.* Cucurbitaccous plants (*Cucurbitaceæ*). *Eupatorium heteroclinium.* Sunflower (*Helianthus annus*).
September ..	Babool (*Acacia arabica*). Castor (*Ricinus communis*). Cumbu (*Pennisetum typhoides*) Gingelly (*Sesamum indicum*). Maize (*Zea mays*). Niger (*Guizotia abyssynica*). Peru (*Ailanthus excelsa*). Sunflower (*Helianthus annuus*). Zinnia.	Balsams (*Impatiens balsamina*). *Chionachne koenigii.* Cucurbitaceous plants (*Cucurbitaceæ*). Gingelly (*Sesamum indicum*). Niger (*Guizotia abyssynica*). Safflower (*Carthamus tinctorius*), Sunflower (*Helianthus annuus*). White babool (*Acacia lekcophloea*).

Months.	Pollen yielding plants in flower.	Nectar yielding plants in flower.
October ..	Castor (*Ricinus communis*). Cholam (*Sorghum vulgare*). *Commelina forskalaei.* Cumbu (*Pennisetum typhoides*). Indian Elm (*Holoptelea integrifolia*). Korai (*Cyperus rotundus*). Maize (*Zea mays*). *Peltophorum ferrugineum.* Peru (*Ailanthus excelsa*). Sunflower (*Helianthus annuus*).	Bendai (*Hibiscus esculentus*). *Chionachne koenigii.* Gingelly (*Sesamum indicum*). Soapnut (*Sapindus emarginatus*). Transpired water from cabbage. Velai (*Gynandropsis pentaphylla*).
November ..	Brinjal (*Solanum melongena*). Cholam (*Sorghum vulgare*). Cumbu (*Pennisetum typhoides*). *Cyanotis axillaris.* Kovai (*Coccinia indica*). Maize (*Zea mays*). Niger (*Guizotia abyssynica*). Paddy (*Oryza sativa*). *Peltophorum ferrugineum.* *Pentapetes phoenicea.* Safflower (*Carthamus tinctorius*). Sunflower (*Helianthus annuus*). Zinnia.	Bitter gourd (*Momordica charantia*). Daincha (*Sesbania cannabinna*). *Dombeya sp.* Fiddle-wood tree (*Cithroxylum subserratum*) (*Flowers after every rain*). Kovai (*Coccinia indica*). *Lagasca mollis.* Niger (*Guizotia abyssynica*). Neringi (*Tribulus terrestris*). Plantain (*Musa paradisiaca*). *Porana volubilis.* Safflower (*Carthamus tinctorius*). Sunflower (*Helianthus annuus*). Sandal (*Santalum album*). Soapnut (*Sapindus emarginatus*).
December ..	Brahmathandu (*Argemone mexicana*). Cumbu (*Pennisetum typhoides*). *Euphorbia heterophylla.* Maize (*Zea mays*). Niger (*Guizotia abyssynica*). Peru (*Ailanthus excelsa*). Sunflower (*Helianthus annuus*). Zinnia.	Cambodia cotton (*Gossypium sp*). *Euphorbia heterophylla.* Niger (*Guizotia abyssynica*). Sandal (*Santalum album*). Sunflower (*Heliathus annuus*).

Besides those mentioned in the list, the following trees, crops and shrubs have also been found to be visited by bees, but accurate information regarding the time of flowering and the status as bee-posturage crops is lacking :—Mango (*Mangifera indica*), Cashew (*Anacardium occidentale*), Sapota (*Achras sapota*), Custard apple (*Anona squamosa*), *Odina wodier*, Pagandai (*Cardanthera balsamica*), *Dalbergia paniculata*, *Eugenia* sp., *Wrightia tinctoria*. *Terminalia chebula*, Korukkapallee (*Pithecolobium dulce*), Blue gum (*Eucalyptus sp.*), Wattles (*Acacia decurrens*), Plums (*Prunus domestica*), Pears (*Pyrus communis*), Peaches (*Prunus persica*), Quinces (*Cydonia vulgaris*), Apples (*Pyrus malus*), Loquats (*Photinia japonica*), Citrus, Himalayan cherry, *Gardenia*, *Averrhoa bilimbi*, Phillipesara (*Phaselous trilobus*), *Senna* (*Cassia angustifolia*), Coffee, Roses, Poppies, Lucerne, Coriander, *Strobilanthes*

sp., Lotus, *Castronia*, *Buddleia*, *Fuchsia*, Broom (*Cytisus scoparius*), Gorse (*Ulex europaeus*), *Rhododendron*, *Leucas linifolia*, *Mimosa pudica*, etc.

Among the pollen yielders maize and cholam are the best and cumbu comes next. Appreciable quantities are also collected from Castor, Zinnia, Peltophorum and the others are only of minor importance. The profuse powdery masses of pollen on the flowers of the graminaceous plants mentioned above, are well known to the ryot. Of the nectar-bearing plants, Cambodia cotton and Tamarind are about the best for the locality. Since the position of the nectaries is generally obscure and the floral mechanism often complicated, a layman is not likely to be aware of the very presence of these in most flowers. The following description might help him in spotting out the nectar-bearing parts in flowers :—

Cambodia cotton.—The crop is generally sown by September-October and begins to flower by November-December. The first flush continues till February and then there is a second one during April or even earlier. The plant bears the nectar glands both in the flowers and leaves. The flowers have two sets of nectaries on the outside. Of these, the first set is found in the shape of tiny depressions at the centre of the base of each of the three leaf-like appendages called " bracts ". The inner set consists of three similar depressions situated just above the junction of the bracts. Small drops of the glistening fluid—nectar—may be found in the nectaries on cloudy mornings. Inside the flowers between the yellow petals and the enclosing green calyx the third set of nectary is present in the form of a narrow band of cells. Since their position is well covered by the petals, it is not accessible to smaller insects but honey-bees with their long tongues are able to reach the spot and suck the fluid. The leaf-necearies (also called extra floral nectaries) are situated on the underside of the leaf, on the midrib and the two smaller veins on either side. Each rib bears only one gland and the total number varies from 1 to 3. The above description is only that of a type but in individual cases the number of these glands vary and in some cases even if present may not function at all.

Tamarind.—These trees begin to flower by April-May and continue to put forth their masses of infloresence till June-July. Next to cotton this is the only source from which nectar supply is of the branches in acropetal succession, i.e., those at the base being assured for a fairly long time. The flowers are borne at the end older and those at the tip younger. There is short stalk for each flower. The petals are only three in number. The one nearest the axis has a sheathing tubular base and is adapted for collecting the nectar which is secreted by the disc all round the flower.

Round about our Apiary, cotton seems to be a very good honey yielder. On a rough estimate, an acre of this crop seems to be capable of yielding more than 10 lb. of honey during a season

but the possibilities are certainly more and require further elucidation.

Bees sometimes take to the luxury of having a drink of toddy if it is available nearby. In apiaries situated near coconut topes where the trees are being tapped for toddy, the bees freely visit the pots and drink the liquid. But how many of these return to their homes, with their undesirable load, is a moot point. While there has not been even a trace of the smell of toddy in the honey extracted from these hives, hundreds of bees are often found floating dead inside these pots which evidently shows that these little creatures after their first few sips of the fermented liquid get intoxicated, lose their senses and get drowned.

Apart from the vegetable sources, bees collect honey from animal sources also. Insects, such as aphids, Coccide, the cholam shootbug, the mango hopper, etc., have the habit of excreting a sweet sticky liquid called honey-dew and when they occur in a pest form, large quantities of this excretion get accumulated on the leaves. It is very common to see ants crowding on these spots and bees also do not lag behind. The sticky liquid is eagerly sought for and stored. But such a condition is not quite normal and bees take to this source only during times of scarcity.

Selective power of bees.—Bees show considerable discrimination in the selection of their pasturage. The preference to a particular source seems to be entirely guided by the quantity of food available per trip. It is neither the smell nor the colour that counts as the following instances will indicate. Very near our Apiary there is a long hedge of Divi-divi (*Caesalpinia coriaria*) with its strong smelling flowers, and so far, not even a single bee has been found to visit these flowers. Again, there are a number of Peltophorum trees round about which burst forth in their luxuriant blooms during February and March. These trees with their attractive masses of fragrant yellow infloresence are really a grand sight. Though other species such as Melipona bees, carpenter bees, etc., eagerly flock to these flowers, our Indian bee would scrupulously avoid them if there is a good field of maize or cholam nearby. Of course, in the absence of anything better, they favour not only these but even more barren sources such as Eupatorium, *Delonix regia*, etc. Observation regarding the quantity of pollen collected, by each bee per trip from four different common sources were made to substantiate the above surmise. The following statement furnishes the details :—

Source.	Average weight of bee.	Maximum weight of pollen load.	Minimum weight of pollen load.	Average weight of pollen load.	Percentage of pollen load weight to body weight.
	GMS.	GMS.	GMS.	GMS.	
Maize	0·0332	0·0232	0·0046	0·0116	34·9
Cholam	0·0391	0·0235	0·0039	0·0112	28·6
Peltophorum	0·0357	0·0158	0·0052	0·0099	27·7
Zinniah	0·0365	0·0254	0·0024	0·0095	26·0

The performance of the hill variety of *Apis indica* was compared with that of the plains variety, the pasturage being periamanjal cholam. The figures are presented in the statement given below :—

Variety.	Average weight of bee.	Maximum weight of pollen load.	Minimum weight of pollen load.	Average weight of pollen load.	Percentage of pollen weight to bee weight.
	GMS.	GMS.	GMS.	GMS.	
Hill variety	0·0455	0·027	0·0078	0·014	30·8
Plain variety	0·04	0·0176	0·0046	0·0105	26·3

Incidentally the ecapacity of the Indian bees was compared with that of Western bee and the details are tabulated below :—

Variety of bee and authority.	Average weight of bee.	Weight of pollen load.	Percentage of pollen load to bee weight.
American bee—			
Gillette	0·081	0·0112	10 to 14 per cent.
Kitzberger	0·08	0·0089	
		0·0129	
Parker R.R.	0·0795	0·015	20 per cent.
		0·0197	
Kellog and Asquith	0·0807	0·0124	9·5 ,,
Indian bee—			
Apis indica (Hill variety)	0·0455	0·014	30·8 per cent for 100 bees.
Apis indica (Plain variety)	0·0381	0·0106	27·8 per cent for 460 bees.

The general findings from these studies are—

(1) The average individual weights of the Plains and Hill varieties of the Indian bee are 0·0381 and 0·0455 grams as calculated from 460 and 100 specimens respectively. The average weight of the European bee is 0·0803 grams.

(2) The quantity of pollen collected by a bee per trip ranges in the order of maize, cholam, Peltophorum and zinnia.

(3) Bees exert a preference to the pasturage in the above order.

(4) The Indian bee is capable of carrying pollen from 26·0 % to 34·9 % of its body weight, the Hill variety 30·8 %, depending on the crop visited. The average capacity of the European bee is 24 %.

(5) Between the Indian bee of the plains and that of the Hills the latter is a better performer.

(6) The Indian bees compare favourably with those of the Western Countries in their collecting and carrying capacity of pollen.

Time of visit.—The time when the bees visit flowers is another interesting item of study. The period of food collection is limited to the time of the opening of the flowers irrespective of other factors. Cotton is visited almost throughout the day for nectar, provided the weather is mild. The nectar from tamarind is sought mostly during mornings and one or two bees can be seen during the afternoons also. Nectar collection from margosa flowers is finished almost by day-break and very few bees are seen on the flowers by 7 a.m. But during mild weather the work is extended for a longer period. Daincha, which forms one of the minor sources of nectar is generally visited during afternoons. The collection of pollen from maize, cholam and cumbu is limited to the mornings up to about 9 a.m. Peltophorum and Zinnia are generally visited in the mornings and sometimes in the evenings also.

Honey is available only from four different sources round about out Apiary and a rough description of these is attempted below :—

Cotton honey.—The colour of this honey is not uniform. Early in the season during December-January it is reddish. But as the season advances the colour is rich golden yellow. Facts are at present wanting to give reasons for this gradation in colour. The consistency is fairly thick and the aroma very light. The taste is very sweet and the quality on the whole excellent.

Tamarind honey.—The consistency is comparatively thinner, the colour rich golden yellow, and the aroma delightful. The taste is quite sweet but as one swallows the honey the slight acidity peculiar to the flower is sometimes felt.

Margosa honey.—This honey more or less resembles tamarind honey in colour and consistency. But the taste and aroma are quite different. During the season when the margosa trees are in bloom, the particular smell of the flowers can be noted in the hive itself. The taste is sweet with a tinge of the margosa flavour. This honey, though available in small quantities, is supposed to have very good medicinal properties.

Honey-dew honey.—The writer's experience is limited only to the secretions of the cholam shoot bug (*Perigrinis maidis*). The product is dark in colour, very thick in consistency with a strong smell of molasses. The taste is sweetish, but the flavour is often too strong and disagreeable. The chemical composition of this honey has, however, been found to be as good as that of any other sample (Ref. St. VIII) and as such there is no reason as to why it should not be used at least in medicine.

CHAPTER X.

CARE AND MANAGEMENT OF AN APIARY.

"The successful Apiarist is he
who cleverly outwits the bee."

—ANON.

Granting that the novice has, with the help of the information furnished in the preceding chapters, procured a few colonies for himself, the hints given in the following pages are expected to give him a working knowledge of the up-to-date methods of tending these colonies. It is not possible to codify the principles with regard to the care and management of an Apiary into a few "dos" and "don'ts" since bees, though associated with man from the remote past, have not yet recognized him as their master. The primary instincts of a bee-colony can be easily summed up as under : (1) the preservation of colony life, and (2) distribution and perpetuation of the species. A normal colony under favourable conditions, gathers sufficient pollen and honey for brood-rearing in its usual

Bees have also been noted to freely visit sugarcane mills in the near vicinity during times of nectar scarcity and suck the sweet juice from the containers, can es under crushing and from the megass. This fluid also is stored in the combs but the honey is dark in colour and lacks the pleasant aroma which is charateristic of the product from floral sources.

course and increases in population. By the time it attains sufficient strength and stores an appreciable quantity of surplus honey, the primitive urge to perpetuate the race gets the upper hand. A number of swarms issue from the parent stock and distribute themselves. This rapid depletion of the strength frustrates the main object of rearing bees. The success or failure of bee-keeping, therefore, depends on the care taken by the owner in diverting all the desirable instincts of the honeybee to his advantage and curbing the undesirable traits. A few factors that go to achieve this ideal are mentioned below :—

I. Selection of site.

II. A knowledge of the habits and requirements of bees.

III. Building up the strength of colonies and their increase.

IV. Incidental and miscellaneous manipulations.

V. Honey—its extraction and preservation. (See Chapter IX.)

VI. Care of the colonies during the slack season.

VII. Bee-enemies. (See Chapter VI.)

A number of manipulations pertaining to the different aspects mentioned above are described in the following pages. The information may be augmented from the vast array of excellent books and publications on European bees and a few on the Indian bees as well; but the quintessence of success in the industry, however, lies more in the owner's love, enthusiasm and natural inclination for the work.

I. *Selection of site* (*Fig.* 29).—(*a*) Among the various districts of the Presidency, natural facilities for bee-keeping appear to exist in Coimbatore, Godavari, Krishna, Chittoor, Tanjore, Tiruchirappalli, Tirunelveli and on the Nilgiris, Kodaikanal, Shevaroys, etc. Even in these tracts the selection of a favourable sité is of primary importance since the future of the apiary depends entirely on the local conditions. Wherever one finds a large number of wild colonies it may be taken for granted that the locality is well-suited for starting an apiary. For a more accurate idea, the flora within half a mile of the proposed site has to be studied in the light of the information given in the previous chapter, and the number of colonies should be judiciously limited according to the availability of pasturage. Besides a plentiful supply of pollen and nectar, bees also require water for their proper maintenance. No special arrangements are necessary to meet the latter requirement since the presence of a well or an irrigation channel nearby is quite enough for the purpose and unless these conditions are satisfied, bee-keeping will not pay in that locality. The agricultural conditions of the garden land areas of Coimbatore are detailed below as these tracts appear to be ideal for successful bee-keeping. The chitrai and periamanjal cholams afford an excellent pollen pasturage during May and November, respectively and the irrigated ragi also provides a supply during July-August. Cambodia cotton which is a good source of nectar starts flowering by November and continues up to

June-July. Margosa trees flower by April. By May-June when cotton and margosa slacken flowering, tamarind trees put forth their masses of infloresence and remain in flowers for about two months. During the short breaks between these sources of their food, the bees maintain themselves tolerably well on the scanty pasturage available from a variety of avenue trees, ornamental and garden plants, vegetable and other sundry crops like brinjals, bhendai, onions, cucumber, castor, safflower, etc., and even from the flowers of weeds such as korai, *Lagasca mollis*, etc. The prickly-pear, which has been practically exterminated by the Cochineal insect, was a good source of pollen.

(*b*) *Location of the hive.*—The hive should be kept in a shady place, well protected from high winds and rains, preferably facing east. It is better to allow the morning sun to play on the hives as it will induce the bees to start work early. Exposure to the severe heat of the sun, is not conducive to the proper working of the colony and it is probably one of the reasons for the frequent desertion of colonies. A tiled veranda facing east would be ideal but it may be too costly. A thatched shed also is quite good. But in the absence of these, the hives may be kept under the shade of trees or bushes with sufficient precautions to protect them from the wind and the rain. An ordinary gunny bag or a piece of date-palm matting wrapped over the top will do for the purpose. A spacing of about 6 feet from hive to hive is necessary. A cheap hive-stand can be made by nailing a piece of thick plank 1 foot × 1½ feet at one end of a thick post and planting its free end firmly in the ground. But it does not give protection against ants, lizards and blood-suckers. Particular attention must be paid to the level of the hive; otherwise the combs will be constructed irregularly.

II. *A knowledge of the habits and requirements of bees.*—An accurate grasp of the habits of the bees is necessary for knowing their requirements and this can be had only by a close observation of their activities both in the field as well as inside the hive. The marvels of bee-life inside their home can be appreciated only by a frequent examination of the colonies. The following hints may be helpful for gathering the necessary knowledge :—

(*a*) *Stings and how to avoid them.*—One of the factors that mars the popularity of bee-keeping is the fear of the sting. The pain inflicted is fairly severe, but it lasts for a few minutes only. The affected portion begins to swell up almost immediately and the swelling as well as the benumbed feeling last for over 24 hours. The after-effects are worse if the sting is received anywhere on the face. The pain and subsequent swelling can be considerably minimized if one understands the mechanism of the sting and its action. It has already been mentioned that when a bee stings, the whole organ comprising of the sting, the poison bag, some muscles, and sometimes a portion of the entrails also gets torn off from its body and is imbedded in the part stung. At first only the tip gets fixed and the serrated needles are subsequently driven deeper and

deeper by the reflex action of the muscles, while the poison is pumped into the puncture. The sting should not, therefore, be pulled out abruptly as soon as it gets imbedded since the pressure applied in so doing only augments the action of the muscles. The whole organ should be scraped off immediately with the finger nail before the muscles begin to act. Bees, though provided with this effective weapon of offence, do not use it without any undue provocation. The factors which irritate and make them sting and a few hints which may help to avoid the painful experience are enumerated below :—

(1) *Inherent bad temper.*—Some colonies are prone to sting without any obvious reason. This is an inherent defect and can be remedied only by substituting the queen with another from a colong having more desirable traits. The vicious temper may also be due to the total neglect of colonies for long periods. In such cases, they can be rendered more docile, by a frequent handling with a moderate use of smoke.

(2) *Inclement weather.*—Bees are generally idle during rainy weather and spells of chill and windy periods. The old bees are unable to go out for foraging and as such are not in a tolerant mood. It is only this category that is capable of stinging badly and as they have no particular work at home they take up the work of protecting the colony against intruders; whereas under ideal weather conditions their attention is diverted towards the more important duty of foraging. The younger bees at home are more keen on protecting the brood and food supply and are not likely to sting. Further there is also a possibility of the brood getting chilled when exposed to unfavourable weather. Bee-colonies should not, therefore, be opened on rainy and chill days.

(3) *Injudicious handling.*—Even at a time when bees are docile and gentle, jerky, nervous and quick motions of the person or the accidental dropping of the combs upset their temper and numbers of them immediately come out in their full fury. A careful calm and steady handling is, therefore, necessary.

(4) *Instinct to protect their young and food supplies.*—All animals, including even man, have the instinctive desire to protect their young as well as their food supplies under adverse circumstances. Bees, being specialized social insects, are not exempt from this propensity. They resent disturbance of the brood-nest. Even on a casual observation, bees may be seen hugging round the brood-combs and the queen when disturbed with a view to protect them. One has, therefore, to be careful while the brood portions are examined. The super-frames can, on the other hand, be handled almost with impunity.

(5) *Desire to protect their kind.*—A similar desire to protect their brethren in distress is also commonly evident. When a bee is injured or crushed by accident, the smell as well as its note of wail attract the other members and numbers of them rush to the rescue and avenge themselves on the enemy. The

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smell of crushed brood also produces a similar reaction. Accidental injury to bees and brood should, therefore, be avoided but when operations like cutting drone-brood, pinching queen-cells, etc., are inevitable, the bees have to be subdued first by smoke, as described in a later paragraph.

(6) *Smell of the stings.*—Apart from the smell of crushed bees and brood, that of their stings also irritates the bees. If a person receives a sting while handling bees it may invariably be followed by many more almost immediately. This can be avoided by slowly moving away from the bees and scraping off the sting with the finger nail. Some green leaf may be rubbed over the spot stung to cover the smell. In the absence of a leaf, the part may be scrubbed with a little water.

(7) *Excitement.*—Bees are in a state of high excitement during play-flights and after a liberal feeding and sting badly when approached. Such colonies should be left alone for the time being.

(8) *Presence of bee-enemies.*—The sudden entry of a stray wasp or fly, a lizard or a cockroach, or any other intruder into the hive, while handling bees will upset their temper.

(9) *Absence of the queen.*—Bees generally get sullen when their queen is missing. This fact can be commonly observed when hiving wild colonies. Under such circumstances the workers do not cluster together into a neat shape as is their habit, but remain scattered. They get more amenable as soon as the queen is spotted.

(10) Bees should not be allowed to enter between the clothing and the body, as they are sure to sting.

(11) They sometimes develop an aversion for rough surfaces such as gunny bags or coarse flannel, etc., and have been noted to sting such objects severely without any provocation.

(12) *Hill bees.*—This variety of *Apis indica* is generally more prone to stinging in its habitat and is particularly vicious just before or immediately after sending out a swarm.

With ordinary care and attention to the hints given above, one should be in a position to handle bees with confidence. A beginner may, however, use a little smoke to subdue the bees. A few whiffs may be blown from a burning rag, either through the entrance or on the top bars of the frames. The smell of smoke frightens the bees. By virtue of their primitive instinct to protect their young ones and food supplies when they scent danger, most of the workers hustle round the brood while some rush to the larder and drink the honey in desperate haste. Consequently, they become heavy and dull and are not prone to stinging. Due care has, however, to be exercised even in the application of smoke. An excess of it simply irritates them all the more and they resort to mass stinging and some of them may be seen attacking even the burning rag. In this connexion, mention may also be made about

the time-honoured adage that one bee sting cures the other which means that a person develops a sort of immunity after a few repeated doses of the poison.

(*b*) *Examining hives.*—Bees should be handled with scrupulous adherence to the points mentioned above. To examine a hive, the top should be first removed as gently as possible. If it is glued to the hive with wax, it may be lifted gently with a knife. The frames should be taken out one after another and scrutinized. The best way to do it, without unduly disturbing the bees, is to first lift one of the side frames, if necessary, with a knife and keep it outside. Extra care will be necessary if the frames are found pasted together with wax. The removal of the next frame will be easier as it can be gently pushed towards the empty space and then lifted up. The near side is first examined. For seeing the other side, the right hand is brought up and the frame is held vertically. It is turned round so as to give a full view of the other side. The right hand is then brought down and the frame is held upside down horizontally. The frame can be brought back to the original position by reversing the process (Figs. 30, 31, 32 and 33). This procedure is necessary since the combs are likely to break by their own weight if carelessly handled. The examined frame can be put back into the hive and the next one taken. The first frame should be put back last. A frame-stand as shown in Fig. 28 may also be found useful. A beginner who is diffident may feel the necessity for a veil for the face and gloves for the hand, but as he gains further experience and confidence, he will soon find that these are not only unnecessary but inconvenient too.

The following points regarding the normal activities of bees should be carefully observed while examining the colony :—

(1) *The queen and her activities.*—Every normal colony should have a queen in vigorous condition and her activities are gauged by the extent of the brood-area. If she is not present symptoms described under " Queenless colonies " will be indicated and necessary steps should be immediately taken to rectify the defect. If, on the other hand, she is present and the brood is sparse, it shows that either she is faulty or the pasturage or hive conditions are not satisfactory. The causes should be gone into and appropriate measures taken. It is also likely that there may be too much of drone-brood even out of the season, which may be due to the advanced age of the queen. These drawbacks can be remedied by substituting the existing queen with a better one or by improving pasturage conditions such as sowing some quick growing crop like maize or cholam and by artificial feeding with sugar syrup according to the exigencies. Any tendency on the part of the colony for prolific egg-laying and brisk brood-rearing should be taken advantage of for providing additional breeding space and thus conserving the energy and time of the bees, as described under " Care of colonies during the breeding season."

(2) *Pollen and honey stores.*—The availability of the food supplies is the only stimulus for brood-rearing and as such the

progress of the colony in their collection and storing should be carefully watched.

(3) *Comb-building.*—Any inclination on the part of the bees for constructing fresh combs indicates the necessity for giving spare combs or foundation sheets.

(4) *Drone-breeding.*—Bees have a tendency to rear too many drones during the swarming season. As these serve no useful purpose, all the superfluous drone-brood must be cut and thrown away.

(5) *Presence of queen-cells.*—The construction of queen-cells is the previous indication for the issue of swarms. This activity should either be encouraged or curbed according to the exigencies.

(6) *Bee enemies.*—A sharp look-out should always be kept for the enemies and prompt control measures taken.

III. *Building up the strength of colonies and their increase*—1. (*a*) *Care of colonies during the breeding season.*—The next step in the theme is to wait for the breeding season and aid the multiplication of the population. This is very important as it is invariably followed by honey-flow when the colonies have to be maintained at their maximum strength. Rapid multiplication, which depends entirely upon the local pasturage conditions, starts by about November at Coimbatore. With the advent of this prosperous period, field-bees evince considerable activity in their foraging work, the queen increases her rate of egg-laying, while the nurse-bees at home construct fresh combs and make the necessary preparations for the expansion of the family. Requisite additional space should now be provided to cope up with the prolific breeding. The queen generally restricts her egg-laying to the central combs as the side ones are reserved for storing food materials. When the central combs are full of brood, the queen is likely to reduce the rate of her oviposition for want of egg-laying space. Placing an empty comb at the centre at this time would not only stimulate the activities of the queen but also conserve the energy and time of the bees which would otherwise be wasted in the construction of fresh combs. As far as possible, clean, fresh and large-sized combs should be given, failing which small pieces or comb foundation sheets may be given as starters. Old dark combs with shallow cells should be avoided as they are rarely worked upon by the bees. If neither of these are available, the side combs may be transferred to the centre. These operations go a long way to aid the natural increase in the population. It is also likely that some of the weak stocks may not respond to the manipulations. It is better to unite these with other colonies. If this is not desired, their population can be slowly increased by giving brood-combs from strong colonies as mentioned under "Swarm prevention." Another method of equalizing the population of a strong and weak colony consists of simply interchanging the positions of the two colonies during a bright morning, when the bees are working briskly. The returning foragers of the two hives by virtue of their homing instinct go only to their

original places and the weaker colony thus gets augmented by the large force of workers from the stronger hive. This method may be practised even with a large number of hives, but special care should be taken to adopt it during the prosperous season and at a time when the bees are working busily; otherwise, it may result in the wholesale fighting and ruin of the colonies. A golden rule followed in the Western countries is to provide each colony with a fresh queen with the advent of the spring, so that brisk breeding may go on and a large army of workers be ready before the ensuing summer. The method can be practised here also if there are proper facilities. A few practical difficulties are likely to crop up in adopting this procedure since the Indian bee does not seem to be capable of rearing good and healthy queens during all seasons. Allowing the first swarm, as mentioned subsequently, may be taken as a compromise, since the original stock gets re-queened automatically. The idea of all these manipulations is to induce prolific egg-laying and brood-rearing, build up the population uniformly in all the colonies and maintain them all efficiently.

(b) *Comb-foundation* (*Figs.* 34 *and* 35).—In cases where old combs are not available comb-foundation sheets may be given. These are thin sheets of wax with small depressions exactly of the size of the worker-cells which are imprinted by a special roller machine. The sheets are fixed to the frame by keeping a piece at the centre of the inner side of the top bar and passing a warm knife-blade dipped in molten wax along the line of contact. The border of the comb-foundation melts on account of the heat applied and the sheet gets fixed when the molten wax solidifies. The bees drag the cells mostly utilizing the wax from the sheets and if it is not sufficient they secrete a little of their own. These sheets are given only during the breeding season to the brood-frames, when bees just commence construction of fresh combs. Sheets given to the supers are not worked upon so quickly. The sheets are available with the Government Entomologist, Lawley Road P.O.

2. *Swarming and its control.*—A judicious application of the manipulations mentioned above would render the colonies sufficiently strong to develop the swarming impulse. This has to be either encouraged or curbed according to the requirements of the apiarist.

(a) *Swarming.*—By the beginning of the honey season, when the population of a colony has sufficiently increased, it is not unusual on a bright morning, at about 9 o'clock, to see a large number of bees hovering about all on a sudden in an excited mood in front of the hive. Within a very short time, larger numbers join them from inside the hive and if the entrance of the hive is closely watched at this time, the queen also may be seen coming out along with the cascade of bees to join in the flight. With the advent of the queen, the bees which were all the while making very rapid circular flights gradually move away. Generally, a third, sometimes even one-half of the colony, takes part in the flight and the buzzing

noise, produced by the rapid movements of such a large number of bees in their aerial gambol, becomes so intense that it can be heard at a distance. Very often, the drones as well as foragers returning from the field join the crowd. This strange caprice goes on for about 15 minutes. Then the circle of flight gets narrowed by which time the queen with a few bees can be seen settling on a branch or any other convenient place near by. The rest of the bees very soon rush up to the spot and gather round the queen, settle down and hang in a pendant cluster with a well-defined bag-like shape. The whole process is called " Swarming " and the group which had thus emigrated in a mass is collectively known as a " Swarm " (Fig. 36). In apicultural language, the word " Swarming " is a special term used to indicate the above process and it should not be confused with " Swarming out " which implies that the colony is deserting wholesale leaving nothing behind except the empty combs. A swarm, after it occupies its place of residence and begins its normal routine is known as a " Colony." The flight of the bees in front of the hive just before the issue of the swarm is only an indication of the impending phenomenon. As a rule, swarming occurs between 9 and 12 a.m. but exceptional cases as in " after-swarms "—may issue during the evenings also. But this should not be mistaken with the play-flights in which the bees indulge almost every day late in the evening. The difference between these two lies not only in the time of occurrence, but also in the behaviour of the bees. In the case of play-flights, the workers can be seen freely going in and out of the hives and the drones, if present, play a prominent part. On the other hand, when swarms issue, the bees literally pour out of the entrance in their hundreds, with very few going in and the air of excitement is more pronounced.

(b) *Swarming season.*—There is no hard-and-fast rule regarding the season for swarming but the fever starts by the beginning of the prosperous season and persists as long as pasturage is available in plenty. It does not occur during adverse seasons. Round about our apiary, the rain-fed cholam flowers by November and at the same time the Cambodia cotton also begins to blossom. From this time onwards, there is a continuity of bee-pasturage till April. The swarming therefore starts by the end of November and subsides with the removal of the cotton crop in April, as there is a break of honey-flow immediately after this crop.

(c) *Causes of swarming.*—Swarming in bees is a potent instinct for the perpetuation and dispersal of the species. Propagation of the race is Nature's law for all members of the animal and vegetable kingdoms. Animals and plants reproduce their own kind, the former by procreation, and the latter by the formation of fruits and seeds, which get distributed either by themselves or by the help of other agencies. In the case of a social creature like the honey-bee, it has modified the means of the continuance of its kind according to its habits. A colony, however much it may increase in strength is after all only one collective unit and if by chance some

accident happens to the reigning queen, the whole lot of the bees have to die out without performing the most paramount of Nature's commands. The bees have therefore, evolved a special method of distributing themselves in the shape of swarms. In the Western countries where *Apis mellifica* has been kept under domestication for years, the problem of swarming has been thoroughly worked out by extensive observations and studies. Various causes such as inconvenient location, congestion, want of breeding space, bad ventilation, lack of work for bees, superfluity of nurse-bees, etc., are said to accelerate this primitive desire. Of late, much has been written about the brood-food theory also. A preponderance of the young bees, which are capable of secreting brood-food is said to occur when the rate of breeding is suddenly accelerated. The enforced idleness of this category due to the lack of adequate young brood to feed, is supposed to incite the desire for the family partition. A re-adjustment in the ratio between the two categories by artificial methods, is said to cure the bees of the swarming fever to a certain extent. So far as the Indian bee is concerned, it is difficult to state that the swarming is more a result of the hive conditions than of the primitive instinct. While it has to be admitted that strong colonies are the first to develop the instinct, probably as a result of the spacial congestion or other causes, there is no reason why weaker colonies with plenty of living space should follow their example. Several such cases have come under the writer's notice and the following example goes particularly against the theory of space-cramping. A small wild colony with a few brood-combs was hived during February 1933 when the swarming fever was literally raging in the apiary. The writer was not sure of the presence of the queen in the new colony though she was there hale and healthy. A sealed queen-cell was taken from another colony and given. The result was most unexpected. Within a week after giving the queen-cell, the inmate reached full development and the existing queen with about one-half of the population went out on a swarm even before the bees had hardly settled in their new home. The new queen emerged in due course and the small colony was found to function quite normally. It would be safer to apply the theory of contagion for this abnormal occurrence. The peculiar note produced by the thousands of workers while on the swarming flight is said to encourage the irresistable impulse in all the other colonies within ear-shot. The arguments presented above go to indicate that the primary cause of swarming, at any rate in the case of the Indian bee, is more the primitive instinct. The mischievous element is always there deeply ingrained, and the hive and seasonal conditions give only an impetus to the natural distribution. Whatever may be the causes of this phenomenon, the persistent desire to swarm is popularly known as " the swarming fever ".

(*d*) *Preparations for swarming.*—The rapid increase in the population of a bee colony may by itself be taken as a prelude to the family partition. More definite indications will be perceptible

in the domestic routine, if a strong colony is examined by about this period. A preponderence of drone-brood, mostly on the two side combs, is the first symptom. After a fairly large number of drones have emerged and many more are under rearing, a number of queen-cells are constructed along the lower border of the brood-combs and a fertilized egg is laid in each. The grubs hatch out in due course and get full grown in about a week after which the cells are sealed. Just by the time the inmates attain the pupal stage, the reigning queen and a large proportion of the workers clear out and establish themselves elsewhere. The swarm which issues first is popularly known as the ' prime swarm '. This is generally the strongest as it may contain a third or one half of the population. It pays to hive and keep it as a separate colony.

(*e*) *After swarms.*—The pupal stage of the queen extends for about 7 days. As already mentioned the first swarm issues soon after the grubs have pupated. The new queens, therefore, emerge on or about the eighth day after the issue of the first swarm. If the population is sufficiently strong at this stage, the fresh queen also goes out with a second swarm. Queens which emerge subsequently, probably the same afternoon or the next day, follow the same example and the process goes on until the strength of the parent colony is reduced to the minimum. Instances have been noted where individual hives had sent out four swarms in the course of twenty days. The age of the queen grubs being more or less the same, two to three queens may, occasionally, emerge almost at the same time. All these follow the next swarm, though only one will be allowed to survive ultimately. Occasionally when the colony becomes too weak to send out any further swarms, the emerging queen may kill all her rivals and even bite and destroy the other queen-cells. These subsequent swarms are known as ' after swarms ' or ' cast swarms '. They are generally weak and it does not pay to hive and keep them separately. They should not be allowed to issue but if they occur, in spite of our precautions, they may be hived and mixed with the original stock as described under ' swarm control '.

(*f*) *Behaviour of swarms.*—A swarm will not go without its queen. In case she does not follow on the first invitation, the workers persist in their hovering flight before the hive until she comes out, which may often take even an hour. Occasionally she may not come out at all for the day. In such cases the workers after aimlessly flying about, return and settle all over the hive taking their own time to enter. But the same process may be repeated the next day, if not the very same evening and until the swarm actually clears out, there would be no peace in the colony. Even the capture and removal of the queen as she comes out along with the swarn does not in any way curb the swarming tendency. When a swarn settles on a branch and if the queen is spotted out and removed, the workers immediately realize her absence and begin to search for her. The whole cluster immediately dissolves itself and the dejected workers return to the hive and wait there patiently

for the emergence of the fresh queen only to swarm once again. Sometimes a swarm can be made to return to the parent hive by disturbing it immediately after it settles but this will in no way cure the bees of their swarming madness. As a general rule, there will be only one queen for a swarm but "after swarms" are occasionally headed by more than one queen. The bees in such swarms either settle as one group as usual or gather themselves in different clusters according to the number of queens present. The time taken by a swarm to move away to its future place of residence may vary from 15 minutes to even 24 hours, depending on the period taken by the scouts in selecting the spot.

(*g*) *Swarm control.*—The tendency to send out a number of swarms is one of the worst qualities attributed to the Indian bee. By their frequent issue the strength of the colonies gets depleted considerably and the harvest of honey is thereby rendered almost impossible. All attempts should, therefore, be made to prevent this phenomenon. A regular multitude of devices and manipulations have been adopted to control this habit in the case of the foreign bee and its response has been encouraging. The study of the habits of the Indian bee is still in its infancy and at present the only popular method is the removal of the queen-cells as they are constructed. In practising this method one of the natural instincts of the honey bee is taken advantage of. Under normal conditions bees construct a number of queen-cells before they go out on a swarm and thus make adequate provisions for a successor to the reigning queen. If this arrangement is disturbed by the above method, they raise another set of cells before they try on a second venture. A colony rarely sends out a swarm unless there is another queen getting ready to take the place of the departing one. Considering the merits of this treatment it does delay the swarming for a few days, but it has its own limitations :—

(1) The initial removal of the queen-cells does not eliminate the swarming impulse as new ones are constructed almost immediately.

(2) Even the temporary relief depends upon the stage of development of the queen-grubs at the time of the removal of the cells. If they are cut away before they are sealed, it delays the swarming until the next batch is ready. But if they are already sealed and the grubs had attained the pupal stage the treatment has often little or no effect. If this systematic destruction is continued for a month or two, the bees urged by the natural instinct, go out on a swarm irrespective of the presence of the queen-cells.

(3) The method can be adopted only when the age of the queen is definitely known; otherwise the indiscriminate prevention of the new queen from coming into existence would render the colony queenless, when the reigning queen dies of old age.

(4) Apart from these, the operation itself is rather tedious. The hives have to be disturbed twice a week throughout the season and the bees often strongly resent this intrusion.

A few other methods which, without going against the natural instincts of the bee, aim at relieving the spacial congestion, providing egg-laying area, and a readjustment of the different categories in the population are suggested below. They may be adopted according to the circumstances :—

(1) If the swarming fever sets in early in the season, the first swarm may be allowed to issue, hived and kept as a separate colony. The parent stock should be carefully examined and the other queen-cells destroyed after the new queen emerges. The population of the original colony is thus distributed over two hives and both may build up sufficient strength and yield honey in the same year as they have the full season before them.

(2) The second method is to periodically examine strong colonies during the brisk breeding season before they construct queen-cells and to remove one or two brood-combs and give them to weaker colonies. Spare or foundation-combs may be given in their place. The removal of the brood-combs and the consequent provision of additional egg-laying space divert the activity of the bees and retards the swarming impulse to a certain extent, while the weaker colonies gradually improve by the augmentation of brood-combs.

(3) The third method is the artificial division described below. The colony is allowed to construct and seal the queen-cells. A brood-comb with the adhering bees and the reigning queen is taken out and kept in a separate hive. This nucleus colony is taken and kept in a far off place, well beyond the range of flight of the bees. The new queen is allowed to emerge in the original colony and the issue of swarms is prevented by the removal of the other queen-cells.

(4) The interchange of position between strong and weak colonies as suggested under "Building up the strength of the colony" is another method which offers scope of swarm-control. If the change is made just before the queen-cells are erected in the stronger colony, the desire for swarming abates to a certain extent because of the considerable depletion of the worker force.

(5) In spite of these precautions, it is likely that one or two swarms may escape. These may be hived (see Hiving Swarms) and kept separate or mixed with the original stock. The latter operation can be done easily. The swarm is first hived in a box. The original colony is then scrutinized and the queen-cells removed. The brood-frame from the swarm is then placed in the original hive and the rest of the bees are shaken on the alighting-board. Both will easily unite, provided it is done without much waste of time. But this method also does not definitely cure the bees of the trouble. In conclusion it has to be admitted that all these methods are only palliatives and further work is necessary for advocating surer manipulations.

(h) *Supersedure queen-cells (Fig. 37).*—A word of caution appears to be necessary in this connection. In rare cases one or two queen-cells may be found even out of the swarming season.

This shows that the reigning queen is getting old and the colony is rearing a new one. The old queen continues to remain in the hive even after the birth of her daughter probably until the latter is sufficiently equipped to take charge of her duties. When she is ready the mother is killed by her own daughter. The old queen is not taken out with a swarm as the bees probably know that it is not worth while. Queen-cells constructed under supersedure impulse can be made out by the absence of worker brood in the combs and their position generally at the centre of brood-combs themselves. They should not be mistaken for the cells constructed under swarming impulse, which are, as a rule, found along the lower border of the combs, and the combs themselves are full of brood.

3. *Increase of colonies.*—If the bee-keeper wants to increase the number of colonies, it may easily be effected during the swarming season, either by hiving the swarms and keeping them as separate colonies or by dividing the colonies artificially.

(*a*) *Hiving swarms* (*Fig.* 38).—A careful watch is kept for the issue of a swarm and it is allowed to settle. An empty hive is got ready. The top is removed and a brood-frame with plenty of eggs and young larvae is taken from a colony and placed inside the hive taking care to see that there are no queen-cells in it. If the comb is from the same colony and if the swarm had issued only just then, the adhering bees may be allowed to remain; otherwise they have to be eliminated as described under "Driving off bees". The hive is then held underneath the pendant cluster in such a way that half of it hangs inside the empty space. Within a few minutes the swarm attracted by the smell of the brood and the comb, will easily transfer itself into the hive. If it does not, the cluster may be gently shoved in with the hands or with a piece of cardboard. There is no fear of the bees stinging as they are generally good natured at this time. If the swarm settles in an inaccessible place, the hive can be slung up to a pole and held in position. The cluster may be gently pushed with a broom tied to another pole. In either case one must make sure that the queen is inside the box. If the major portion of the swarm gets in, it may be taken for granted that she has entered the hive. The few bees that might be hovering about will soon enter the box. The empty frames can now be placed and the box closed with the top. The hive can be kept at a distance of about 20 feet, from the original one. The brood-comb inside encourages the swarm to settle in the hive and by the time all the young brood emerges as adults the swarming impulse abates. Swarms hived in empty boxes invariably desert immediately. The above method of hiving a swarm has been found to be the easiest, for the operator will be exposed to very little stinging and at the same time it causes the least inconvenience to the bees. Almost cent per cent success attends such attempts. It has been found that capturing swarms is decidedly the best method of starting new colonies. It is not only easy, sure and quick (the whole operation can be done in 15 minutes) but the bees also

have been definitely found to establish quicker and yield honey earlier than wild colonies caught. The following statement would amplify this fact :—

STATEMENT IV.

Swarm number.		Date of issue and hiving.	Date of first extraction.	Period taken for the swarm to yield honey from date of hiving.	Total quantity of honey yielded.	
				DAYS.	LB.	OZ.
XXI	..	14th November 1932.	31st December 1932.	48	5	7
XXII	..	15th November 1932.	Do.	47	8	10
XXIII	..	8th November 1932.	Do.	53	6	8
XXV	..	9th November 1932.	4th February 1933.	87	2	8
XXVI	..	15th December 1932.	17th February 1933.	65	10	4
XXVII	..	4th December 1932.	4th February 1933.	62	0	10
XXVIII	...	28th December 1932.	9th February 1933.	43	2	8

The only difficulty about this method is that the bee-keeper has got to keep a careful watch for the issue of the swarms. But this trouble also can be eliminated by the use of a simple device known as "the swarm trap (Fig. 39)". This consists of a rectangular box open at one of its broad sides and a wire-gauze fixed at the front side up to about two-thirds of the height. The lower third of this side is fitted with a queen-excluder sheet in a slanting position. After the bees construct queen-cells, this box is kept on the alighting-board with its open side close to the hive and well-secured with a piece of string taking care to see that there are no slits to allow either the bees or the queen to escape. One or two frames with comb foundation sheets are kept inside the contrivance. The swarm issues in the normal course and the bees fly out; but the queen is not able to follow them because of the obstruction by the wire-gauze and queen-excluder sheet. After a period of aimless wandering inside the trap, she settles on the frames with a few workers. The bees that were till now flying about return to the hive through the queen excluder sheet and form a cluster inside. The swarm is thus induced to settle inside the swarm trap. The frames along with the bees may be transferred to a hive at convenience, but care should be taken to give a brood-comb immediately. The advantage of this trap is, as already mentioned, that the bee-keeper need not watch for the issue of the swarms. Occasionally the bees may settle on the outer surface of the queen-excluder instead of on the frame. In such cases the bees as well as the queen inside the trap have to be transferred to the hive as in "Hiving swarms".

(b) *Artificial swarming.*—Artificial or forced swarming is another method of increase of colonies wherein they are divided by certain manipulations in accordance with the habits of bees.

A colony having its queen-cells in sealed condition is selected. It is opened on a bright morning when the bees are brisk, the frame with the reigning queen is taken and kept in a new hive after removing the queen-cells, if any. The hive is then filled with the frames having comb-foundation sheets or spare combs. The original hive is either kept at right angles to the old place or removed to a distance of about 20 feet and the new one kept in its place. The returning foragers join the new hive and thus an artificial swarm, having a queen, a brood-comb and bulk of the field bees is created. The old hive is kept under observation and the queen-cells are removed after the emergence of the new queen. Though the above procedure is one of the accepted methods of the West, it does not somehow seem to be suitable for the Indian bee. Bulk of the bees join the artificial swarm in the new hive, leaving most of the brood-combs uncovered in the parent hive. This necessitates the transference of a few more brood-combs from the old hive which renders it weak. But the modified method of artificial division described under swarm control offers a better promise.

(c) *Care of swarms*.—As a general rule, newly hived swarms begin to work very soon. They may be fed on a little dilute honey or sugar syrup to stimulate them. Old combs or foundation sheets also can be given with advantage.

IV. *Incidental and miscellaneous manipulations*.—A knowledge of the following incidental operations necessary for the proper management of an apiary would be useful :—

(1) *Uniting*.—Uniting, as the name implies, is the mixing of two or three colonies into one. This may be done for various reasons such as for uniting a queenless stock with another having a queen or to unite two weak colonies into a strong one, etc. There are several methods and two of the easiest are given below :—

(a) *Direct uniting*.—The colonies to be united should be first brought together and kept side by side moving them gradually towards one another (see "Shifting bee colonies"). The hives are now examined for the queens and the one having any undesirable traits is removed. The latter hive is left alone for 24 hours so that the members may realize the absence of the queen. The next morning, when the bees are working busily, the hives are opened and the frames with bees from both the hives are gently kept together in one hive. The success of this method depends on the skill of the person and the care with which it is done as well as on the activity of the bees at the time of uniting. Inclement weather or any careless handling results in fighting and loss of bees.

(b) *Newspaper method*.—This is a safer method as it involves very little risk. The colonies that are to be mixed are brought together and one of them dequeened, as in the previous case. But the actual uniting is done only after the dusk, when the bees are inside their respective hives. The colony having the queen is now opened and its brood-chamber is covered with a sheet of newspaper. A few holes are then made on the paper, with the

sharp end of a pencil. The floor-board of the queenless hive is now removed and the brood-chamber is then kept over the newspaper. All sources of egress are closed, preferably with a wire-gauze, and the two colonies are left alone for the night. The imprisoned bees in both the hives, scenting the presence of strangers, slowly begin to investigate, through the small openings in the newspaper. The two different hive-odours get mixed and the union is accomplished within a short time. The wire-gauze at the entrance of the lower hive can be removed early next morning, and the hives opened when the weather gets brighter. The bees would have nibbled big holes in the paper to establish an easy passage. It is likely that they may be found separately in the two hives but the frames can be safely got together.

(2) *Queen rearing.*—In the Western Countries, this is a specialized art, demanding careful manipulations with the help of a few special appliances. But the poor honey yield of the Indian bee does not justify any elaborate care and expenditure on this account though there may be a frequent necessity for spare queens. The following simple methods may, therefore, be adopted to get a few "nucleus" colonies each with a queen:—

(*a*) Two or three small hives each to hold two or three frames are first made. A colony with desirable traits, having plenty of eggs and young larvæ is then selected. The brood-combs of this colony are then taken out and distributed in the smaller hives. The old hive is removed and the smaller ones are kept in its place close together in a row. A few cells containing the just hatched larvæ may be enlarged by cutting the adjacent cells. Only one grub should be allowed to remain in the enlarged cavity and the others removed. The bees scarcely seem to take any notice of the change and continue their normal work. Only one of the hives will have the queen. The others soon begin to raise their own, with the result we get two or three small colonies each with a queen.

(*b*) The "Demarree" method of swarm prevention also presents a very easy and convenient method of queen-rearing. The procedure is briefly as follows: A colony having a queen with desirable traits and with plenty of brood and eggs is selected. The brood-comb with the queen and bees is taken out and kept in a separate hive. The rest of the frames are given either with foundation or spare combs. A "Queen-excluder" sheet is placed on the top of the brood-chamber. The floor-board of the other is removed and the whole hive with the other brood-combs and bees is kept over this. The entrance of the upper hive is closed and both the boxes are tied securely so as to prevent their toppling over. The queen-excluder prevents the queen from having any access to the upper chamber as a result of which the workers there begin to rear queens out of the fertilized eggs by constructing cells either in enlarged spots on the comb itself or along its lower border. After these cells are sealed, the frames along with the bees and the

queen-cells are taken out and distributed in a few empty hives. About half a dozen nucleus colonies are thus obtained from a single colony.

The success of either of these methods depends on the prosperity of the season. Healthy queens are reared only during periods when pasturage is available in plenty. These small colonies can be utilized for uniting with queenless stocks. It is not worth-while to keep these as separate hives since they rarely attain sufficient strength to collect and store surplus honey within the season. The above methods are rather crude and slow. They are not the recognized practices in places where better methods of bee-keeping are in vogue, but are suggested only to meet the needs of an amateur bee-keeper under South Indian conditions.

(3) *Queenless colonies and their care* (*Fig.* 40).—It is common for colonies to lose their queens during the swarming season. This is probably due either to their getting lost or being preyed upon by insectivorous birds while they are on their nuptial flight. For a bee-keeper with a little experience it is easy to make out a queenless colony from its appearance. The first external indication is that the bees are not as busy as they ought to be and bring less of pollen. Within a few days their abdomen gets contracted, presenting a dark colour and some of them will be found resting idle in front of the hive during the morning hours. As the day advances other members join the group and the cluster goes on increasing in size until the entire front of the hive gets covered by the evening . The dark colour of the bees is rendered more unsightly when a large number of them remain huddled together. It is also likely that a few particles of wax might be found secreted on the wooden surface. These bees return to their original place even if they are mechanically transferred into the hive. These features are very characteristic of queenless colonies.

Conditions inside the hive.—During the initial stages, the absence of the queen is indicated by the paucity of eggs and young grubs in the cells. By about this time, the bees also realize her absence and make frantic efforts to rear new ones from the existing eggs or grubs, either by enlarging the size of the cells or by constructing queen-cells below and transporting the grubs to these. When these attempts fail some of the "laying workers" begin to lay numbers of eggs in each cell. The other workers discard the superfluous number leaving only one in each. The grubs hatch out of these in due course but develop only into drones. The bees, sometimes in their anguish, lose their heads and even construct big queen cells over these larvæ only to feel disappointed at the emergence of a male, when all of them have been eagerly expecting the birth of the future prop of the colony. The drone-grub in a worker-cell can be easily distinguished. As already mentioned the worker-cell is smaller and the drone larva bigger. The latter looks as if it has been thrust into the smaller cell. Such cells get distended and the shape is irregular. Several such grubs in the comb ruin its very appearance and the entire surface gets

frames along with the queen. The bees immediately cluster round the queen and begin to lick the honey. The smell of the latter which attracts the bees, probably neutralizes the individual odour of the queen also and by the time she gets rid of her coating, she is accepted by the colony. If before the introduction of the queen by either method, the workers have laid eggs and the grubs hatched, all such combs should be cut away leaving about three or four rows of cells on the top as these generally contain only honey. If honey is found in the cut combs they may be placed in front of the hive for a time so that the bees may drink it off. In the absence of any stored food the colony may be fed artificially to facilitate comb-construction which the bees do with remarkable rapidity, under such circumstances. Provision of spare comb foundation sheets also will be helpful.

When all these methods have failed, the last resort would be to unite the queenless hive with a small colony having a queen, preferably by the newspaper method. The necessity for small colonies, with queens as mentioned under " Queen rearing " may, therefore, be reiterated here as they are quite useful under such emergencies. The whole secret of success in re-queening lies in the promptness with which it is done. Any unnecessary delay is likely to ruin the temper of the bees and after a time they refuse to work on the fertilized eggs, much less to accept a queen.

(4) (*a*) *Shifting bee-colonies.*—It may be found necessary to shift bee-colonies from place to place or even to transport them to long distances. While doing this it must always be borne in mind that bees have a particularly strong homing instinct which has been developed almost to a disadvantage. Powers of good perception and a strong memory for the landmarks enable them to dash back to the hives with unerring exactness from their foraging excursions. If the hive is removed even by a few inches when the work is going on briskly, it takes a little time for the returning foragers to find out the entrance and if it is removed by 6 or 7 feet, they persistently hover about the original place until they drop down and die of exhaustion. Even if they are caught in an empty hive and introduced into the original one they come back to the old place. For these reasons, whenever a hive is to be shifted from one place to another within the apiary itself it should be done gradually by about 2 feet per day. The moving should be done only after dark and the effect of even this change can be seen the next morning. The bee-keeper will find by experience that it is better to do even the slow moving once in two or three days. On the other hand, it is easier to shift the colonies to a distance. The hives can be removed during nights after closing the entrance with a piece of wire-gauze. When colonies are approached during night time, it is very likely that a large number of bees may be found clustering at the entrance, especially during the summer months. These can be driven inside either by gently blowing on the group or slowly tapping the floor-board. A light should not be taken too near the hive as a few bees may be

attracted to it. The maximum distance travelled by the bees by virtue of their homing instinct is fourteen furlongs, when only very few bees were found to return to the original place. The new site should be beyond this range. If the hives are moved to shorter distances, a bulk of the foragers return to the original spot, the number being inversely proportionate to the distance.

(*b*) *Transport of bee-colonies.*—Hives with bees can stand even long journeys provided they are packed carefully. Prior to packing the hive, the brood-combs should be well-secured with plantain-fibre to avoid their getting broken or damaged during transit. One or two combs having honey should then be included to provide food during the journey. Free ventilation is of utmost importance and this may be effected by placing an empty super over the existing one or brood-chamber as the case may be. The entrance should first be closed temporarily to prevent the bees from coming out and annoying the operator during packing as it has to be done during day-time. A wire-gauze sheet, having 18 meshes to the square inch, should then be nailed on the top of the empty super. The floor-board, brood-chamber, super, etc., may then be fixed together by nailing a few pieces of thin reapers and all of them tied together securely with a string. The entrance may now be opened but plugged finally with wire-gauze after nightfall after all the bees are inside the hive. The precautions mentioned in the previous paragraphs should be observed while approaching bee-colonies after dusk. The packed hive can ordinarily be taken without the top but it may be put on if there is the risk of exposure to the sun or chill weather. In case the journey extends over one or two days, the floor-board may be removed and another sheet of wire-gauze nailed at the bottom of the brood-chamber and the bees fed either with dilute honey or sugar syrup during the journey. The entrance may be opened soon after arrival at destination and the wire-gauze sheets removed at leisure. It is likely that some of the combs might have broken during the journey and these should be fixed back immediately.

(*c*) *Behaviour of shifted colonies.*—When a hive is shifted to a new place, the bees, on coming out the next morning, reconnoitre the new surroundings. A good number of them hover about the hive and when tired settle and crowd anywhere on it. They seem to forget even the entrance since many can be seen trying to get in through the ventilator openings on the top. But they get accustomed to the place in two or three days and begin their normal field activities. During the first few days, the action of returning foragers would clearly indicate that they have not yet become used to the new surroundings. They will be seen hesitating for a second or two in front of the entrance before entering. After they settle down, they arrive at the entrance straight as an arrow and in their hurry to get in, some of them with heavy loads of pollen lose their balance and perform somersaults on the alighting board before entering.

Our experience shows that such shiftings should, as far as possible, be avoided since the colonies get a set-back from which they take over three weeks to recover. To study the effects of shifting, five colonies were first weighed and transported from our apiary to a village about 2 miles off. They were weighed on alternate days in the new locality. In spite of the fact that the latter place afforded much better pasturage facilities, there was a steady decline in the weights of all the hives for the first ten days, and it took another ten days for them to attain the original weight. The maximum loss was about 1 lb. 4 oz. and the minimum $6\frac{1}{4}$ oz. The decrease is partly due to the rapid consumption of the reserve food-materials and also to a good number of the field bees straying away. Egg-laying and brood-rearing were not materially effected as long as food was available. Incidentally mention may be made of another aspect of the strong memory of the bees. When colonies are shifted from an apiary to a distant place and brought back within six weeks and kept anywhere near the original place, the returning foragers, by virtue of their memory have the habit of going back to the old spot instead of returning to their hive. But this difficulty can be avoided if the colony is brought back after about two or three months, i.e., after the generation of the bees accustomed to the old place have died out.

(*d*) *Sending queens by post.*—Queens can be sent by post in specially designed cages, two patterns of which are shown in Fig. 41. The end cavity is packed with sugarcandy to serve as food during transit and a piece of wire-gauze is nailed over the entire top and one end of the cage leaving only the other end free. A queen and about 20 workers are introduced through this opening and it is then closed. The address is nailed on the top or tied loose in a cardboard and the cage is sent by post. On arrival at destination, the wire-gauze at the end with sugarcandy is removed. The cage is kept inside the queenless colony and the hive closed. The workers eat their way through the candy from either side, by which time the hive-odour of the strangers gets amalgamated and the queen is accepted. The recipe for the preparation of the candy is given below :—

Candy.—Sugar (granulated), 10 lb.
Cream of tartar, one teaspoonful.
Water, $1\frac{3}{4}$ pints.

Mix the above and place the vessel over a low fire. Stir constantly to prevent burning until all the sugar is dissolved, then bring to boil and allow to continue for exactly three minutes. Remove from the fire and set in a bath of cold water for a few minutes. Now stir vigorously with a wooden spoon until it whitens like thin gruel and then pour into moulds.

(5) *Drone control.*—Drones occur in excessive numbers during the swarming season and even after the new queen has got mated they are allowed to remain in the hive as long as the honey supply lasts. They can be found gathered together either on the

top of the brood-frames or in the supers. They may be destroyed as described below, if they are not eliminated by the bees themselves. The super is taken out and the top put on, the former is kept open for a short time. The bees being frightened by the exposure to light, drink the honey stored in the combs and become heavy and inactive. The frames are then taken one after another, and the drones picked out and crushed with a pair of forceps. During this process it is likely that some of them will escape and fly back to the hive. Their entry can be prevented by placing a drone-trap at the entrance temporarily. This trap is a simple contrivance (Fig. 28) consisting of a piece of wood slightly longer than the entrance of the hive with a shallow cut about 1/8 inch deep and 2 inches in length. It is kept close to the entrance with the cut end below. The narrow slit is just enough to allow the workers insidë but the drones, being slightly bigger in size, are left behind. They can be conveniently picked and crushed. The trap can also be used with advantage during play-flights, when most of the drones come out. Another effective method is to examine the brood-chamber frequently during the season and to cut away all superfluous drone-brood.

(6) *Driving off bees.*—While managing a large number of colonies, it may be often necessary to drive the bees off the combs to give them to other colonies, for hiving of swarms, honey extraction, etc. This could be accomplished by taking up the frames and shaking the bees in front of the hive. But this method is not always safe since the combs are likely to break off and the bees also sometimes get irritated and sting badly. Another method is to take out the frames and brush down the bees, either with a feather or with a brush. This process involves considerable time without minimizing the chances of getting stung. The work can be accomplished with greater ease by keeping the frames with bees in an empty brood-chamber or super, as the case may be. The box is then held before the parent stock with the upper border of the front-side just touching the end of the alighting-board (Fig. 42). A little smoke is then applied from below. The bees being scared by the smell of smoke will rush out " en masse " sticking up their tiny abdomen, which is by itself an obvious indication of their demoralization and fright and enter the hive. A few bees which might be still clinging to the combs can be easily blown off. This method is quicker and comparatively safer from stings.

V. *Honey—Its extraction and preservation.*—Refer Chapter XI.

VI. *Care of colonies during the lean season.*—The adverse cycle in the progress of the colonies follows in the wake of the breeding and honey season. At Coimbatore, the prosperous season comes to an end by July when high winds start and continue up to September, making it equally difficult for both man and beast to go

out. Bee-pasturage also is equally scarce in the field on account of the peculiar local agricultural practices. There is very little brood rearing on account of these adverse factors and as there is not enough output of young bees to compensate the natural loss of the older ones, the population dwindles down so rapidly that there may not be enough bees to cover even two or three frames by September. The colonies should be looked after carefully during this period and their strength maintained as best as possible. The wax-moth now reigns supreme and no pains should be spared to guard against this pest. As the colony gets weaker and weaker, all the superfluous empty combs should be removed and stored carefully. Weak colonies can be given a dummy board (Fig. 28) to keep up the temperature and provide the necessary compactness.

Artificial feeding.—Under the circumstances indicated above, a little artificial feeding, either with dilute honey or sugar syrup would go a long way to help the bees in maintaining themselves. The food can be given in a cigarette tin with a piece of muslin tied over its mouth and the tin kept inverted inside the hive. If it is not available, a regulated quantity of the food can be given by pouring the liquid over the frames (Fig. 43). In either case necessary precautions have to be taken to keep off ants, which, attracted by the smell of sugar, invade the hives in numbers. Colonies situated side by side should not be fed simultaneously as it often leads to robbing and fighting among the bees. The feeding should be resorted to only when there is a dire necessity and should be stopped as soon as a sufficient quantity of the liquid is found stored in the cells. Liberal feeding results in the bees gorging themselves with the unnatural food which in its turn brings about an undue strain on their digestive system. All this trouble can be avoided to a certain extent, if an adequate quantity of honey is left behind in the comb prior to the last extraction. Incidentally samples of honey extracted from hives which were liberally fed on sugar syrup and jaggery solution separately show that their chemical composition is as good as the natural produce, but the inherent pleasant flavour is lacking (see Statement V). As regards pollen substitutes, European bees are said to readily utilize articles such as rye, oats, cotton seed, linseed and pea meals, milk powder, white of egg, spores of fungi and sometimes less nutritious foods such as fine saw-dust, fine particles of clay and even coal-dust when driven to the necessity. Such substitutes are not suited to the taste of the Indian bee. Trials with bengalgram flour, pea and linseed meals and klim milk, given alone and in combination with honey, failed to attract the bees. Under natural conditions even the stray pellets of pollen collected and stored by the bees in the cells are not utilized if they drop out by accident, but are carefully brought out and thrown away. Therefore, the only remedy to relieve such pollen scarcity would be to provide the bees with their natural food, by raising quick-growing crops such as maize, niger, sunflower, etc., in the near vicinity.

STATEMENT V.

Analysis of honey extracted from hives fed on sugar syrup and jaggery solution.

Number and heads of analsis.	Amount. Sugar-syrup honey.	Jaggery honey.
1 Direct polarization	—1·25	—10·51
2 Moisture	21·70 per cent.	23·36 per cent.
3 Ash	0·30 ,,	1·56 ,,
4 Reducing sugars	61·05 ,,	65·49 ,,
5 Sucrose	12·96 ,,	2·95 ,,
6 Diastatic activity	One gram of honey is able to convert 0·34 c.c. of 1 per cent starch solution.	One gram of honey is able to convert 5 c.c. of 1 per cent starch solution.
7 Acidity	29·85 c.c. of N/10 alkali for 100 gm. of honey.	41·0 c.c. of N/10 alkali for 100 gm. of honey.

The moisture contents of both the samples and the sucrose contents of the sugar-syrup honey are high.
(Analysis by the Government Agricultaral Chemist, Lawley Road P.O.)

VII. *Enemies of bees.*—Refer Chapter VI.

Before concluding the chapter, the breeding and swarming habits of the bees during the different months of the year at Coimbatore may be epitomized in the following statement :—

STATEMENT VI.

Month.	Pasturage. Pollen.	Pasturage. Honey.	Brood-rearing. Worker.	Brood-rearing. Drone.	Swarming.	Comb construction.
January ..	Available in plenty.	Available in plenty	Very brisk ..	Plenty ..	Very persistent.	Very brisk.
February ..	Do.	Do.	Do. ..	Do. ..	Do.	Not so brisk.
March ..	Do.	Do.	Do. ..	Decreasing.	Do.	Rather dull.
April	Slack ..	Slack ..	Do. ..	Slack ..	Slack	Nil.
May	Available in plenty.	Available in plenty.	Do. ..	Decreasing.	Nil	Comb constructed if honey available.
June	Do.	Do.	Slackening.	Do.	Do.	Slack.
July	Slack ..	Slack ..	Slack ..	Very little.	Do.	Nil.
August ..	Very slack.	Practically nil.	Very poor ..	Nil ..	Do.	Do.
September ..	Do.	Do. ..	Do. ..	Do. ..	Do.	Do.
October ..	Do.	Do. ..	Do. ..	Do. ..	Do.	Do.
November ..	Getting better.	Fair ..	Fair ..	Begins ..	Begins ..	Begins.
December ..	Good ..	Do. ..	Very brisk..	Do. ..	Very persistent.	Very brisk.

The lean season generally extends from July to October when the population of colonies dwindles in strength. It is during this time that the bee-keeper has to bestow great care on the hives. Empty combs should be removed and stored, leaving only just enough number for the bees to cover. If available, dummy-boards must be provided inside the hive and the entrance narrowed. The hive and the combs should be frequently examined for the wax-moth. The bees should be fed on dilute honey or thick syrup, at least once a week. By about the end of November, the colonies

begin to increase in strength and the combs of the previous season can now be given. When the brood-chamber is full of bees supers if possible with combs, can be added. From December onwards up to April it is indeed a very busy season for the bees as well as for the bee-keeper. Along with the increase in population the swarming fever starts. The hives must be examined once or twice a week and necessary steps taken to prevent the issue of swarms. Drones and drone-brood will be noted in excessive numbers and these should be destroyed.

The progress of an average colony was closely watched for a period of nearly one year, constituting the lean, breeding and honey seasons and the details regarding the fluctuations in the population, brood-rearing and the field activities during the different seasons are recorded below to furnish some authentic data in support of the cursory information furnished above :—

STATEMENT VII (*a*).

Date. (1)	Total population in weight. (2) LB.	OZ.	Weight of field bees. (3) LB.	OZ.	Weight of house bees. (4) LB.	OZ.	Percentage of field bees. (5)	Percentage of house bees. (6)
17th June 1940	0	14	0	9¼	0	4¾	66	34
8th July 1940	1	½	0	5¾	0	10¾	34·8	65·2
29th July 1940	1	½	0	1¼	0	15¼	7·6	92·4
19th August 1940 ..	1	1	0	2	0	15	11·8	88·2
9th September 1940 ..	0	13¾	0	2¾	0	11	22 0	80 0
30th September 1940 ..	0	11½	0	2¼	0	9¼	19 6	80·4
21st October 1940 ..	0	6½	0	3	0	3½	46·2	53·8
11th November 1940 ..	0	7½	0	5	0	2¼	69·0	31·0
5th December 1940 ..	0	12¾	0	3½	0	9¼	2 ·5	72·5
26th December 1940 ..	0	10½	0	5¼	0	5¼	50·0	50 0
21st January 1941 ..	0	15¼	0	8½	0	6¾	·55·7	44·3
17th February 1941 ..	0	15½	1	12¾	0	2¾	82·3	17·7
12th March 1941 ..	1	2	0	15¼	0	2¾	80·7	15·3
22nd April 1941	1	2¾	0	12	0	6¾	64·0	36·0

STATEMENT VII (*b*).

Date.	Brood area in square inches. (7) WOR.	DRO.	Number of trips for pollen collection. (8)	Number of trips for nectar collection. (9)	Food stock in square inches. (10)
17th June 1940	113·5	Nil.			
8th July 1940	69·0	Nil.	..	..	106·8
29th July 1940	41·1	Nil.	..	..	73·8
19th August 1940 ..	17·1	Nil.	1218	..	34·3
9th September 1940 ..	No queen.		157	1 317	35·0
30th September 1940 ..	33·6	Nil.	87	1,085	17·7
21st October 1940 ..	57·8	Nil.	384	2 744	6·7
11th November 1940 ..	121·6	Nil.	1 102	3,307	6·6
5th December 1940 ..	145·0	Nil.	3,040	7,425	34·0
26th December 1940 ..	161·5	Nil.	1,314	9,959	Nil.
21st January 1941 ..	216·4	4·1	2,885	8,727	10·9
17th February 1941 ..	255·9	6·6	5,353	5,918	16·9
12th March 1941 ..	278·3	28·7	3,414	7,040	129·2
22nd April 1941 ..	303·0	7·6	5,582	18,907	74·1
			3,907	12,987	153·4

Worker brood—one square inch = 39 cells.
Drone brood— do. = 36 cells.
Weight of bees—One ounce = 735 bees.

(The colony was rendered queenless by September on account of the frequent and drastic handling. Though a new queen was introduced soon after, the continuity of the observations was interrupted for a month. The colony was allowed to revive again and the observations were continued from October onwards.)

The data indicate the following :—

(1) Taking the progress of the colony from June to August, the total population as well as the proportion of the house bees to field bees are on the increase which shows, that new bees continue to emerge from the sealed brood and that most of them keep idle indoors, due to unfavourable pasturage and weather conditions. The brood area and the food stocks show a steady depreciation which indicates that brood-rearing is at a standstill and the reserve food-material is being consumed.

(2) Taking the next season, October to December, a decrease in the population is recorded at the beginning which indicates that the old bees are dying and the rate of breeding does not compensate the loss. During December an all round betterment of the activities is evident. In the first week the percentage of nurse bees is very high, which, when considered with the brood-rearing activity, shows that the colony has begun to make up for the loss of old bees. The proportion is equalized by the end of the same month. The food stock is low probably because of its being consumed by the rapidly enlarging family as quickly as it is gathered.

(3) The next period from January to March, constituting the honey season, shows remarkable compensation in all the phases of activities. Drone-brood also occurs, which means the colony has attained its maximum prosperity and is preparing for the inevitable family partition.

CHAPTER XI.

Honey : Its Extraction, Preservation and Uses.

" Of all the meals you can buy for money,
Give me a meal of bread and honey ".

—Richard Le Gallienne

Honey is a sweet viscid fluid containing about 60 to 75 per cent of invert sugars, about 5 per cent of sucrose, and certain minerals such as Phosphorous, Calcium, Magnesium and some acids, enzymes, etc. The fluid is prepared by bees from nectar.

STATEMENT VIII.

Chemical composition of honey.

Heads of analysis.	Honey-dew honey.	Cotton honey.
Direct polarization at 29°C.	— 6·0	— 11·2
Invert polarization at 28·5°C. ..	— 4·8	— 8·8
Moisture	15·58 per cent.	14·89 per cent.
Ash	1·2 do.	0·47 do.
Reducing sugars	66·53 do.	73·96 do.
Sucrose	6·51 do.	5·84 do.
Free acid number of c.c. of N/10 KOH for 100 grams of honey ..	84·1 c.c.	45·24 c.c.
8 Diastase reaction	Brown at 45°	Deep blue at 45°

(Analysis by the Government Agricultural Chemist' Agricultural College, Coimbatore.)

Chemical composition of nectar.—Nectar is a complex material containing a considerable percentage of water, a few chemically different sugars, minerals, acids, colouring and flavouring materials and enzymes. The presence of the colouring and flavouring matter is responsible for imparting the special aroma and colour to honeys from certain sources. The bulk of the sugars contained in the nectar consists of only cane sugar but small quantities of dextrose and levulose are also said to be present.

Conversion of nectar into honey.—The process of conversion of nectar into honey is complicated and interesting. It has already been mentioned that bees hold the nectar in their honey-stomach and on their return to the hive, regurgitate the fluid into the honey-cells. During the short period the nectar is inside the stomach of the bee, it is predigested and undergoes certain changes due to the action of an enzyme known as "invertase" present there. This enzyme acts upon the cane sugar and splits it into dextrose and levulose. According to certain workers on the subject, field bees on their arrival transfer the nectar to the nurse bees for the maceration, and during this process further quantities of invertase are added to bring about the complete inversion of the sugars (Fig. 44). This is only the chemical aspect of honey manufacture. Even after the conversion and transfer to the cell, the fluid contains an excess of moisture and is likely to ferment if stored straightaway. Therefore the bees waste no time in getting rid of the superfluous moisture. The winging action of the bees, described in Chapter V, evaporates the moisture to a certain extent. Further dehydration is brought about by the bees taking in the stored fluid again and macerating it for a time in their mouths and regurgitating it back into the cells. The whole process of eliminating the superfluous moisture by the bees themselves is called the "natural ripening" and the cells containing such "ripe" honey are then sealed with wax.

Honey extraction.—Vigorous development of a colony will invariably be followed by honey-gathering and storing. The following paragraphs give details regarding its extraction and preservation :

(*a*) *Honey season.*—Round about our Apiary the main honey season starts by the end of November and continues up to March. Then there is a break for about a month and with the advent of the tamarind flowers by early in May, the honey-flow starts again and lasts till July. But this should not be taken as a general rule, as it is likely to vary considerably from place to place and from season to season according to the pasturage conditions. Instances of such variations are noted even within a distance of a few furlongs, incidentally showing the very limited range of flight of the Indian bee. Along with the rapid accumulation of honey, breeding is also carried on briskly. The five central combs contain plenty of brood and the two side ones and sometimes a few top rows of cells in the central combs also are generally stocked with honey and pollen.

(*b*) *Adding supers.*—In Nature, the Indian bee stores honey at the two side-combs but under artificial conditions they are induced to rear brood exclusively in the lower chamber and store honey in the super. The latter is to be added when all the seven frames in the brood-chamber are full of brood and food supplies, with enough population to cover all the combs. The condition is indicated by the gathering of a large number of bees on the lower plank of the roof and at the entrance during nights. To start with, only one super is to be given and as the colony increases in strength a second one may be added. Indian bees in the present type of hive scarcely need a third super but exceptionally strong colonies may require it for a little free space if not for storing honey. Since bees show very little inclination to construct combs in the super, the provision of an adequate number of empty combs proportionate to the strength of the colony is necessary. The two side combs of the brood-chamber which are generally well-stocked with honey, may be taken out, cut to the size of the super-frames, and fixed with plantain fibre. Ordinarily two such combs will be found enough for four frames. If all the seven combs are full of brood, the few rows of cells immediately below the top bar may be cut and fixed to the super-frames if they contain honey and the lower brood portions given back to the brood-chamber. In the absence of these, pieces of empty combs may be given. If after giving the combs to the super there is still plenty of honey sealed in the brood-combs, the bees can be made to bring it up by scraping away all the cappings. Bees should not be encouraged to store honey in the brood-chamber as the egg-laying space would be curtailed. Occasionally drone-brood might be found in the super-combs but fortunately this habit does not persist. The trouble can be easily remedied by cutting away such cells and discarding them.

(c) *Removing combs for extraction.*—As already stated the honey-cells are sealed after all the moisture has been evaporated from their contents. This is called ripe honey. The honey prior to sealing is known as "green or unripe honey". Though it would be ideal to have all the honey-cells sealed prior to extraction, it is not worthwhile to wait for this stage. Combs having about 75 per cent of the cells sealed can be taken out for extraction. Sometimes bees remain idle without sealing the cells even after they are full of honey. These combs also can be taken and the honey extracted, just to stimulate the bees, but in either case the material has to be processed artificially as described in a subsequent paragraph. The bees can be eliminated from the honey-combs as described under "Driving off bees" (Fig. 42). This process is somewhat slow. In cases where a large number of hives are maintained, the "Porter bee-escape" a cheap and simple device can be used for emptying the supers **(Fig. 45). This** is a trap-like contrivance which allows only one way traffic for the bees. This is fitted on a screen-board having the same dimensions of the super. The board is placed the previous night between the super and the brood-chamber with the circular opening facing up. The foragers gathered in the super go out for work through the opening the next morning, but are prevented from going up again, by the trap-like device.

(d) *Uncapping.*—The sealed cells have to be uncapped, before extracting the honey. The comb is held firmly in one hand with the top-bar above as shown in Fig. 46. A sharp table-knife is then dipped in hot water kept flat on the sealed surface and the cappings are shaved off gently by to and fro movements. The warming of the knife is to keep the edge sharp as it gets stricky while cutting the wax. It is better to have two such knifes, so that one may be kept in hot water while the other is being used.

(e) *The honey-extractor and method of its use (Figs. 47 and 48).*—The honey-extractor consists of a cylindrical drum and a box inside to hold the super-frames. The box is fixed to a rod at the centre and the revolution is effected by the action of a set of two gear-wheels. The frames with the honey-combs are kept in the slots provided in the comb-box and the latter is gently rotated. While in rotation, the honey is forced out in droplets by the action of the centrifugal force. As there is a central partition wall between the two sets of cells, the liquid contained in the outer side only is extracted. The contents of the other side can be extracted by changing the position of the frames. The machine should be worked slowly at first and the speed increased gradually as the weight of the combs gets reduced by the elimination of its contents. A fast rotation in the beginning itself would cause snapping of the combs. Particular care should be taken when handling heavy combs and those that are flimcily attached to the frames. In such cases winding a broad strip of plantain fibre round the comb and frame would obviate the chances of its breaking off. The honey thus extracted falls into the metal drum and

comes out through the outlet. The liquid can be collected in a vessel after straining it through a piece of fine moist muslin. The material should be ripened artificially and stored as explained subsequently. The pattern of machine shown in the figure has been found to be quite efficient and the extraction of one side can be completed in about a minute. The work should be done at some distance away from the apiary and if possible, in a closed room, since bees attracted by the smell of honey, are likely to come in numbers and annoy the operator. There is no hard and fast rule regarding the interval between two extractions, since it evidently depends upon the availability of nectar and on the rapidity with which it is gathered and stored by the bees. At Coimbatore during a particularly good season, it was found possible to have an extraction once in ten days from the same hives. It is needless to reiterate here about the advantages of the extractor over the primitive and wasteful method of squeezing the combs.

Artificial ripening.—It has already been mentioned that a pure sample of honey may contain about 15 per cent of moisture. Any quantity in excess of it is likely to bring about fermentation and the subsequent deterioration of the material. In Nature, the honey cells are sealed when the contents have reached the optimum condition and the honey extracted exclusively from such cells does not require any further treatment. But in practice it is likely that a good number of the cells are not sealed prior to extraction and the admixture of this stuff may affect the quality of the bulk honey. For these reasons the extracted honey should be ripened artificially prior to storage. The process consists of subjecting the honey to a temperature of 60° C in a water-bath for about half-an-hour. Direct contact of the vessel with the water-bath recepticle should not be allowed and hence it should be made to rest on a piece of wood or any other non-conducting material. The process not only pasturizes the honey and removes the excess of moisture but also clears it of certain impurities which are contained in some samples and collect at the top as a scum. The floating material can be easily skimmed off. Subjection of the product to direct heat, as well as to higher temperatures or for longer periods will ruin its quality and destroy the enzymes which are so vital for a good sample.

Bottling and storing honey.—Honey is best stored in glass or enamel or earthen vessels. Metal containers must be avoided, since certain acids contained in it corrode the metal and spoil the quality. The receptacles should be tightly closed and stored in a cool and dark celler.

Fermentation.—Honey, however carefully it may be extracted and ripened, has the property of absorbing moisture from the air, if preserved carelessly. This moisture is favourable for the development of certain organisms known as "yeasts" which in their turn cause fermentation. Fermented samples get sour and rancid and evolve considerable quantities of carbon-di-oxide. Unripe

honey is sure to ferment very soon even if preserved carefully. Flimsy containers stocked with this fermented material are likely to burst on account of the pressure of the gas from inside. Samples that are generally sold loose in the bazaars by the retailers are mostly in this condition.

Granulation of honey (*Fig.* 49).—Honey is a compound of different sugars. If it is stored for a long time, dextrose which forms nearly 30 per cent separates itself out in the form of crystals, but the time taken for the separation varies with the samples. Before this crystallization the honey gets a little cloudy in colour. Small crystals are now found in suspension which gradually increase in size and number, and form the beautiful white sediment. Honeys from different sources are said to contain varying quantities of this sugar and samples that contain a larger quantity of this component granulate more quickly. The atmospheric temperature also is said to control the granulation. Alternation of cold and warm weather hastens the process and honey can, therefore, be made to granulate artificially by subjecting it to low and ordinary temperatures on alternate days. Good granulation in honey is by itself a proof of its purity but partial granulation in streaks might be due to adulteration with sugar. When honey granulates in bottles it may not be easy to pour it out but it can be liquified by keeping the bottle in the hot sun or warm water for a short time.

Thickening of honey.—There is a general opinion that samples of South Indian honeys are too thin and do not have the desirable degree of consistency for table purposes. Trials were undertaken by the Government Agricultural Chemist, Coimbatore, to improve the viscosity. It was found possible to improve the consistency by keeping honey in wide-mouthed vessels inside vacuum desiccators over concentrated sulphuric acid and exhausted with "Hyvac" pump, maintaining a constant pressure of 12 mm. of mercury. The results show that the combined influence of exhaustion and long exposure to sulphuric acid in vacuum increases the viscosity. The consistency of an ordinary sample was improved almost to that of jam by a treatment extending up to 72 hours.

Difference between honey and sugar solution.—Though both are sweet to the taste the fundamental difference lies in their chemical composition. As already mentioned, honey contains the predigested invert sugars dextrose and levulose—which can be directly assimilated by the system, whereas sugar consists of sucrose only and is also lacking in the enzymes, invertase and diastase. The former has the property of converting raw sugars into easily assimilated ones, and diastase acts upon the starchy foods and converts them into sugar. It would be out of place here to go into the details about the action of these enzymes inside the human stomach, but suffice it to say that they are very necessary for the proper digestion and assimilation of our food.

Uses of honey and honey bees.—The ulility of honey bees as honey and wax-yielders and as cross-pollinating agents is well-known. Apart from this, even their stings are said to have some curative properties. Their use as a remedy for arthritis and rheumatism appears to have been so widely appreciated that there are even a few publications on Bee-venom Therapy. A regular dose of three stings a week is said to have given relief in many cases. The stings are also believed to have the power of restoring blood circulation in cases of paralysis. Internal administration of honey is also recommended for these ailments.

A vast array of recipes advocating the use of honey in medicine is available and a gist of it is given.

Honey as a food.—Honey, on account of its easily assimilable properties, can be taken as a substitute for sugar especially in cases where the digestion has been impaired by old age or disease. In diabetic cases where the use of raw sugars is prohibited, honey serves as a good substitute. For athletes and persons who have strenuous physical exertion in their daily routine, it is a good item of diet, since the simple sugars are easily absorbed to replace those consumed in the blood and muscle, by the exercise. One or two teaspoonfuls of honey in a glass of hot milk is said to be a good night cap. For children the use of honey as a general tonic has been known from time immemorial.

As a disinfectant and an antiseptic.—Germs causing typhoid fever, dysentery and various other infectious ailments of the alimentary canal have been found to be unable to thrive in the medium of honey. A judicious internal administration of honey in such cases, might render the digestive system aseptic.

Honey is also advocated for contused wounds, septic ulcers and carbuncles which are ordinarily very difficult to be healed. The wounds should be dressed with honey and the application renewed every 24 hours after a warm fomentation. For superficial bruises and abrasions, its application not only gives immediate relief but also acts as a protective coat when it dries up. It is also an excellent remedy for severe cases of burns and scalds.

For sore-throats, coughs and colds.—From time immemorial honey has been advocated as a soothing agent for the above complaints. A table-spoonful with a teaspoonful of fresh coconut oil thrice a day is said to have excellent effects against cold. Honey and lime-juice in equal parts is a good cough mixture. A table-spoonful of honey held in the mouth and swallowed slowly relieves the tickling sensation in the throat and the annoying cough.

For the teeth.—Excessive use of refined sugars is said to bring about various ailments of the teeth and honey is advocated even as a curative for these troubles.

For a weak heart.—Honey is reputed to be an excellent specific for a weak heart. A table-spoonful of it, when the attack is on, is said to have very beneficial effects. Even during other serious

illnesses, such as typhoid, pneumonia, when the patient is passing through the crisis, it can be given as a heart stimulant.

For constipation.—Honey is a demulcent and laxative but care should be taken to regulate the dosage. It should at first be taken in small quantities and the dose gradually increased. Large quantities taken at a time are said to cause flatulence and gripe.

For tapeworms.—An emulsion of peeled pumpkin seeds 3 oz., honey 2 oz. and water 2 oz., half of which to be taken in the morning in empty stomach and the other half taken later, followed by 2 oz. of castor oil two hours later is advocated for tapeworms.

For ear-ache.—A drop of honey and sweet oil dropped into the ear is said to give wonderful relief.

As a thirst quencher.—In addition to the excellent medicinal properties, honey is supposed to be a good thirst quencher. Arabs take honey and water along with them before they start on long journeys across deserts.

Apart from being used as a specific for a number of complaints, honey can be taken regularly in the place of sugar as it is reputed to be a general tonic for the brain and the digestive system.

The medicinal properties of honey have been known to our indigenous systems of medicine from the earliest of times. A perusal of some of the standard publications on Ayurveda shows that our ancestors knew as much about the uses of honey as the present-day physicians. "Sushrutha Samhitha" by Sushrutha and "Ashtanga Hridhayam" by Vaghbatta, two of the classical works on Ayurveda, give the various medicinal uses of honey in a few slokas. In the former even a crude classification of the bees, in relation to their habits, has been attempted. Eight different kinds have been enumerated and the honey collected by each variety is said to possess particular medicinal properties. What is more important in the above publications is that only fresh honey is advocated as medicine and heated honey for enemas, emetics, etc. Further the books prohibit the administration of pure honey even along with hot liquids. It may also be of some interest to mention here the various uses, as enumerated in the above publications. Fresh honey is a common vehicle for the preparation of several electuaries and tonics. Its use is advocated either by itself or as an important constituent of the specifics for the following complaints :—

(1) Eye trouble (honey collected from lotus flowers is said to be best for the purpose).
(2) Antidote for poisons.
(3) Hiccup.
(4) Different kinds of internal hæmorrhage.
(5) Blood pressure.
(6) Leprosy.
(7) Diabetes.
(8) Intestinal worms.

(9) Vomiting.
(10) Asthma.
(11) Diarrhœa.

It may also be mentioned here that honey plays a prominent part in "Kayakalpa" the indigenous rejuvenation treatment the merits of which have been recently brought to the notice of the public.

CHAPTER XII.

ECONOMICS.

"He who knows not what has happened
In three thousand years will never
See the light nor have experience
Even should he live for ever."

—GOETHE.

The following statement gives the total yield of honey for eleven hives for a year beginning from October 1932 to July 1933 :—

STATEMENT IX.

Hive No. 1.

Date of extraction.	Quantity extracted. LB.	OZ.
30th September 1932	2	0
19th October 1932	1	8
1st November 1932	1	6
10th November 1932	1	10
17th February 1933	1	2
27th February 1933	1	2
20th March 1933	1	0
10th April 1933	1	0
20th May 1933	0	12
4th July 1933	0	8
Total	12	0

Hive No. 3.

Date of extraction.	Quantity extracted. LB.	OZ.
10th September 1932	0	8
30th December 1932	1	14
25th January 1933	0	14
10th February 1933	2	0
27th February 1933	2	8
21st March 1933	1	2
10th April 1933	1	4
4th July 1933	0	4
Total	10	6

Hive No. 5.

Date of extraction.	Quantity extracted. LB.	OZ.
15th January 1933	1	4
20th February 1933	2	0
27th February 1933	1	8
20th March 1933	1	0
10th April 1933	1	2
29th May 1933	1	0
4th July 1933	0	2
Total	8	0

Hive No. 8.

Date of extraction.	Quantity extracted. LB.	OZ.
30th December 1932	2	0
25th January 1933	2	4
10th February 1933	3	0
27th February 1933	3	0
10th April 1933	0	4
29th May 1933	0	12
4th July 1933	0	6
Total	11	10

Hive No. 11.

Date of extraction.	Quantity extracted. LB.	OZ.
31st December 1932	2	0
26th January 1933	1	0
9th February 1933	1	8
28th February 1933	2	12
21st March 1933	1	0
11th April 1933	0	8
Total	8	12

Hive No. 13.

Date of extraction.	Quantity extracted. LB.	OZ.
30th September 1932	1	0
19th October 1932	1	6
1st November 1932	0	13
10th November 1932	1	4
31st December 1932	0	8
26th January 1933	1	4
9th February 1933	1	0
28th February 1933	1	2
11th April 1933	1	0
Total	9	5

Hive No. 14.

Date of extraction.	Quantity extracted. LB.	OZ.
30th September 1932	2	0
19th October 1932	1	12
1st November 1932	1	4
10th November 1932	1	4
4th February 1933	1	0
17th February 1933	1	12
28th February 1933	1	2
21st March 1933	1	2
11th April 1933	1	0
Total	12	4

Hive No. 15.

Date of extraction.	Quantity extracted. LB.	OZ.
1st November 1932	1	0
30th December 1932	1	10
25th January 1933	1	4
10th February 1933	1	8
27th February 1933	2	0
20th March 1933	3	4
10th April 1933	3	4
29th May 1933	2	4
4th July 1933	0	12
Total	16	14

Hive No. 20.

Date of extraction.	Quantity extracted. LB.	OZ.
13th December 1932	1	2
25th January 1933	1	0
4th February 1933	1	4
27th February 1933	3	8
21st March 1933	0	12
10th April 1933	1	4
29th May 1933	0	6
Total	9	2

Hive No. 22.

Date of extraction.	Quantity extracted. LB.	OZ.
31st December 1932	1	8
20th January 1933	1	4
29th January 1933	1	8
28th February 1933	2	2
21st March 1933	1	12
10th April 1933	0	8
Total	8	10

Hive No. 26.

Date of extraction.	Quantity extracted. LB.	OZ.
17th February 1933	1	0
20th February 1933	1	8
21st March 1933	2	12
11th April 1933	3	0
29th May 1933	1	12
4th July 1933	0	4
Total	10	4

The total quantity of honey obtained is 117 lb. and 3 oz. and the average yield per hive comes to 10 lb. 12 oz. nearly. For eleven colonies the money value of the produce at Re. 1–4–0 a pound is Rs. 146–7–9.

Besides the honey, each of these colonies gave out a swarm, which when hived and looked after carefully for one and half

months began to yield as shown in the Statement No. IV. Unfortunately the progress of these swarms could not be observed since most of them had to be disposed off to meet the keen demand from the public, but for all practical purposes, each swarm can be expected to yield half the quantity of honey as that of the parent which means 5 lb. and 6 oz. or in money value Rs. 6–11–6. Since these swarms yield the above amount in the first year itself their value may safely be taken as Rs. 7 each and for 11 swarms it comes to Rs. 77. Therefore the total outturn from 11 hives is Rs. 146–7–9 plus Rs. 77 or Rs. 223–7–9.

The amount expended on these hives may now be considered.

* *Capital outlay.*—(1) Cost of 22 hives at Rs. 4 each comes to Rs. 88. (The hives are made of superior teak and neatly painted. The carpenter's wages at Coimbatore are fairly high. Dealwood is quite ample and if the hives are made in the villages the cost can be reduced to about Rs. 3.)

(2) Cost of the honey extractor, Rs. 10. Cost of hiving 11 original colonies at Rs. 2 each comes to Rs. 22. Therefore the total outlay is Rs. 120.

The interest on the capital outlay at 7½ per cent comes to Rs. 9 roughly. The hives and the extractor are expected to last at least for 15 years and, the annual depreciation for these comes to Rs. 6–8–0. No depreciative value need be calculated for the amount spent on the capture of the colonies since the latter are a permanent acquisition and do not depreciate.

The labour charges are practically negligible since it is enough if the owner attends to this work during his spare time. Anyhow for purposes of calculation, we shall take it that he spends one day in a week from November to March—a period of five months for queen-cell cutting, honey-extraction, etc. Calculating his wages at 6 annas per day it comes to Rs. 8–4–0 for 22 days. The labour spent on looking after the hives during the off-season is still less and a lump sum of Rs. 1–12–0 may be allotted under this heading, making a total of Rs. 10 for the year as labour charges.

Therefore the annual running expenditure for maintaining these 22 colonies (11 original and 11 swarms) may be summed up as follows :—

	RS.	A.	P.
1 Interest on outlay	9	0	0
2 Depreciation	6	8	0
3 Labour charges	10	0	0
4 Sundries	4	8	0
Total ..	30	0	0
The gross income from 11 hives per year	223	7	9
Total expenditure for maintaining these	30	0	0
Net income for 11 hives	193	7	9
Therefore, average net profit per hive ..	17	9	5

* The figures are based on the cost of materials then prevalent and are not, therefore, comparable with the present rates. They may, however, be taken as indicative.

Before proceeding further, it may be mentioned here that the investigations on the economic aspects are by, no means, complete. Pasturage conditions round about our Apiary are not as favourable as they ought to be. Cambodia cotton which is the main source of nectar for the locality, is pulled out as a regular practice after the first picking, thus depriving us of the benefit from the second flushes. Secondly, the area round about entirely lacks in tamarind trees and the yield mentioned above has, therefore, been more or less exclusively from the first flushes of cotton. In a ryot's field where the crop is generally kept on for two flushes, the yield may be higher and if there are any tamarind and margosa trees nearby the prospects are still better.

Taking all these things into consideration, even a net profit of Rs. 17–9–5 per hive is by no means a negligible amount. A ryot can easily manage about 25 hives without feeling the strain, provided he has the will and the inclination to do it. But for a beginner it is better to start with three or four hives since it would effect a considerable saving in capital outlay and as he gains further experience he can expand the work from the sale-proceeds of the produce.

The public are fast realizing the medicinal and nutritive qualities of honey and as such the pure stuff always gets a ready sale even at fancy prices.

Future work.—It is presumed that the preceding matter of this booklet would have indicated the possibilities of rearing the Indian bee for profit and pleasure. It has, however, to be admitted that their average performance is not at all encouraging when compared with that of the European bee in the Western countries. The reasons are not far to seek. The seasonal and climatic conditions of the temperate regions are such that the bulk of the flowering of most of the vegetation is concentrated during the short period of the summer months. The bees occurring in these regions have developed almost an instinctive urge to collect and store the maximum quantity of the food-materials, within this period for the ensuing long period of dearth. The pasturage conditions also are definitely more favourable. The vegetation is more varied and the nectar yielders probably secrete more of the fluid under the milder climatic conditions. The practice of growing extensive areas of Clover for dairy cattle which is one of the richest sources of nectar, is a major factor contributing to the high yields. Further the inherent high fecundity of the queen, augmented by careful selection and breeding for years, helps the bee-keepers to build up the colonies to enormous strengths. In addition to these advantages, the bracing climate enables the bees to work for longer hours than in the hotter regions. In contrast to the European bee, its Indian cousin is subjected to a number of limitations. Firstly, in our land of agricultural wealth and plenty with no drastic variations in the seasons, pasturage is available practically

throughout the year, though the bulk of the flowering is concentrated from November to May. As a result of this, our bees have not developed a better working capacity. The number of working hours also are shorter because of the hotter climate. The fecundity of the Indian queen bee is rather low and this defect coupled with the confirmed swarming propensities, makes it well nigh impossible to build up the colonies to the desired strength. In spite of the scant attention, it has received from scientists, it is gratifying to note that the performance of our bees, in some of the favourable localities, has been recorded as high as 40 lb. of honey per colony per year. The information furnished in Chapter IX regarding the pollen carrying capacities of the different categories indicates that our bees, given the proper care and attention, are capable of even competing with the foreign bees.

It is also the considered opinion of the author that from the work done so far, adequate fundamental knowledge regarding the life-history, habits, pasturage requirements and management of the Indian bee, has been acquired to run an Apiary successfully. The quintessence of further work, therefore, lies mostly in the selection and breeding of queens of higher prolificity which can, in their turn, produce better bees with non-swarming propensities, milder temper, better working capacity and other desirable traits. The evolution of a bigger type of hive and more elaborate appliances will automatically follow these investigations. But it must be mentioned here that keeping the Indian bee is certainly not a short cut for fortune. But as a cottage-industry coupled with other items like poultry-keeping, it would go a long way to supplement the ryot's scanty income from agriculture. Apart from the profit, bee-keeping is the best method of utilizing the nectar from the flowers of the ryots' crop which would otherwise go as waste, leaving aside the enormous indirect benefit accrued to the country's resources by cross-pollination.

Conclusion.—While pleading the cause of the Indian bee it is not intended to decry the European bee in any way. In spite of the fact that they are better performers in their natural habitat, careful consideration is necessary before venturing in any ambitious programme with them. Firstly, it is prohibitively costly to import these, not to speak of the risk involved in the probable loss of the brood and bees during transit. It is still a matter of doubt whether these bees would thrive properly under South Indian conditions. Desultory attempts have been made here and there without any notable success. Further, these creatures are hopelessly subject to several infectious diseases which are exceedingly difficult to control. Our bees, as far as we know, are free from any of the serious pestilances and if at all anybody thinks of importing the foreign bees, care should be first taken that the diseases also are not imported along with them, as it has been the unfortunate experience with several insect pests affecting cultivated crops.

Once the diseases get an entry within our shores and begin to affect the indigenous bees, the prospects of successful bee-keeping in India will be very gloomy. In this connexion it will be interesting to quote the resolution passed at the "Third Entomological Meeting, Pusa, 1919", on the subject:—

"*This meeting considers that there is considerable danger of the introduction into India of bee diseases by the unrestricted importation of bees, beeswax and honey from countries infected with such diseases and that such importation should only be permitted under necessary restrictions.*" As such, trials with foreign bees have to be made with great care

APPENDIX I.

Rock Bee honey, its Extraction, Preservation and Wax-extraction.

The Rock bee (*Apis dorsata*) has been the main source of honey in India from time immemorial, though the quality of the material available to the public is poor, on account of the impure and fermented condition when it reaches the consumer. A study of the existing methods of honey extraction and preservation was, therefore, taken up and the possibilities of improvement explored.

This bee is the biggest of the indigenous honey bees. Its favourite haunts are hilly tracts and forest areas, mostly above 2,000 feet elevation, but stray colonies migrate down to the plains during the monsoon months. Swarms of this bee establish themselves in the open in inaccessible places such as precipitous cliffs and over-hanging rocks, branches of tall trees, etc. Occasionally 50 to 60 colonies are found on a single tree. The combs are built singly and very often reach three feet in length and about two feet in breadth. The top portion of the comb where honey and pollen are stored extends to about nine inches in height and bulges out to a width of about six inches. Brood is reared in the lower portion. This bee is a very good honey-gatherer and a strong colony may yield up to 40 lb. The domestication of this bee is out of question because of its undesirable traits and peculiar comb-building habits already mentioned in Chapter III. The possibilities of improvement, therefore, lie only in the evolution of more hygienic methods of extraction and the proper preservation of honey.

Existing methods.—The handling of these bees and the collection of honey and wax are the exclusive monopoly of the jungle tribes. The colonies are approached during seasons of honey flow and the "modus operandi" is briefly described below:—As a general rule they are handled only after night fall. The ingenuity, coolness and daring exhibited by these "Children of the forest" while tackling the colonies of these dangerous insects are simply amazing. Before beginning the work they fortify themselves against any accident or attack by the bees by a preliminary "puja" to propitiate the jungle deities; the offerings being a small quantity of rice, jaggery and a little incense. In cases where colonies of the bees are situated under overhanging rocks, the approach often extends over a few hundreds of feet over steep precipices, a slip from where would mean certain death. The equipment required for tackling the colonies and collecting the honey are a few lengths of forest canes tied together with jungle fibre or a sufficient length of strong fibre rope, a kerosene oil tin open at the side and slung to a long rope and the inevitable smoking torch. One end of the cane or rope is well secured to a tree at the top and the man gets down to the work-spot with the help of this improvised ladder. The task is comparatively easy in the case of colonies situated on trees, as these men could easily climb up even to the dizzy heights at which the colonies are found. When there are a number of colonies on different branches of the same tree, they move from branch to branch with the help of the bamboos tied across them. The crowning feat of their admirable

skill and daring lies in the fact that all this work is done during dark nights. When they have to tackle a larger number of colonies they are able to camp whole night either under the rocks or on the trees.

Regarding the collection of the honey, the bees are first brushed aside with the smoking torch. The lower portion containing brood is then broken off and sent down in the kerosene tin. These brood combs are kept for the extraction of wax but the jungle tribes also relish small quantities of the brood either raw or boiled. The empty receptacle is sent up again to get the honey-bearing portions. The entire operation takes about five to ten minutes. The honey-combs are taken and the adhering pieces of brood, dirt and other impurities are removed and the honey is squeezed with the hands. The produce is either handed over to the contractors or sold immediately to local inhabitants and no attempts are made to store it. It is needless to add here that the methods are very unclean and the quality of honey poor, on account of the admixture of considerable quantities of dirt, pollen and possibly some brood-juice as well.

Cleaner methods were subsequently adopted by the Forest department. The honey, obtained by the above method was filtered, heated directly over fire, filtered again and stored in kerosene tins. The process, though an improvement over the then existing crude methods was still far from being perfect. There is always a possibility of large quantities of pollen getting forced out along with the honey when it is squeezed out by the hand. The presence of the extraneous matter as well as the contamination by the hand cause rapid fermentation. The direct heating over the fire ruins the essential qualities of honey and probably destroys the enzymes as well.

Trials of improved methods.—Three contrivances, namely, (1) The honey strainer; (2) the honey-extractor; and (3) the wooden churn-staff extractor were designed for the hygienic extraction of honey and found quite satisfactory.

The honey-strainer (*Fig.* 50).—This consists of two vessels kept one over the other with a thick wire-net (4 meshes for 1 inch) partition between the two. The honey-combs are first procured, cut into small bits with a clean knife, scrupulously eliminating all dirt, brood portions and as far as possible, the pollen-bearing cells also. The pieces are then tied in a thin muslin bag and kept inside the upper vessel of the strainer, so that the honey may gradually ooze out by mere gravitation. It takes three to eight hours for the bulk of the honey to drain out; the period varying according to the viscosity of the material which again depends upon the source from which the nectar was collected. The quality of the honey was satisfactory though the period taken was fairly long.

The honey-extractor (*Fig.* 51).—This was designed after the model of the machine commonly used for the Indian bee (*Apis indica*) with certain modifications. It consists of a cylindrical metal drum 1½ feet in height and 2 feet in diameter and a comb-box. Two movable wire-gauze cages each 9″ × 6″ × 1′ are provided in the comb-box for holding the honey-combs. Whole pieces of the latter, each measuring about 9″ × 6″ × 6″ as well as small bits, in all weighing about 10 lb. were worked at a time in the machine and almost the last drop of honey was thrown out in about 10 minutes. The machine is thus more efficient than the strainer on account of the quickness of operation as well as the lesser chances of contamination.

The churn-staff extractor (*Figs.* 52 & 53).—This consists of a rectangular wooden frame fixed to a thick wooden rod to effect the rotation. The frame is made to hold one of the wire-gauze cages of the extractor and is also provided with a small peg at the bottom. The latter is received into a socket in the centre of another block of wood, which when fitted on tightly to the bottom of any ordinary vessel holds the churn-staff in position without wobbling, when it is rotated. The wire-gauze cage with the uncapped honey-combs is kept inside the frame and the central staff is rotated with a piece of rope as in the case of the country-churn. This machine also is equally efficient, its special feature being its simplicity and cheapness.

In the use of all these contrivances, a certain amount of admixture of pollen is inevitable. This is due to the peculiar habit of this species in storing honey and pollen side by side indiscriminately, sometimes, even in the same cells. These small particles are able to pass through even fine muslin and have to be eliminated subsequently. A certain portion of it comes up along with the scum while processing the honey and what little is left over, collects at the top after the honey is bottled and kept. This layer of the extraneous material may be removed later. Special mention has to be made here about the necessity for ripening the product as in the case of *Apis indica* honey, because of the impurity incorporated during the removal and subsequent handling of the combs.

Drained honey.—A certain amount of bad handling and crushing of the combs are inevitable when they are collected. A considerable quantity of the honey drains out in the vessel itself during transit, partly due to the bad handling, but mostly due to the pressure exerted by the weight of the combs themselves. An appreciable quantity of brood, bees, as well as other extraneous matter such as lumps of pollen, broken bits of twigs, leaves, pieces of burnt sticks, etc., are invariably found floating in this honey. There is nothing wrong with the produce except for the temporary contamination but it should be filtered, ripened and bottled immediately. Special attention should be paid to the promptness with which it is treated, since the dead grubs, pupæ and bees are likely to decompose very soon.

Destruction of rock-bee colonies.—Swarms of these bees sometimes settle near human habitations. Any casual disturbance like throwing of a stone by urchins, the smell of smoke, etc., irritates them and they soon begin to attack indiscriminately. Under such circumstances the necessity for the destruction of the bees arises. Burning the colony with a lighted torch is neither convenient nor efficient. The whole colony can be easily killed by dusting a few handfuls of Calcium cyanide on the cluster after nightfall. The chemical being dangerous, due care should be taken in handling it.

Wax extraction.—Wax is another precious product of the bees which is in high demand for commercial purposes. The extraction of this material necessarily involves destruction of the combs and the procedure is not recommended for the combs of the Indian bee. But it is inevitable in the case of the Rock bee, for reasons already mentioned. A short account of the local method of extraction is furnished below. The combs are first cut into small bits and boiled in water for about half an hour. The boiling mixture is then poured into an improvised filter made out of the leaf-sheaths of the coconut

which is held in the shape of a bag. High pressure is then applied over its solid contents with a pair of wooden rollers and the last particle of the fluid is thus squeezed out into another receptacle containing cold water. All the wax contents in molten form pass out with a considerable amount of impurities. The wax solidifies at the top surface of the water as it cools. This is then taken, kneaded and heated again in another vessel directly over the fire. The impurities that may float on the surface are removed and the molten liquid is poured into moulds which are generally small pits scooped out in the ground with the sides pasted neatly with cowdung. The hardened material represents the crude sample, which is ordinarily available in the bazzar. It requires further purification before it is put to use. This can be effected by melting the sample again in water. During the process the molten wax comes to the top and solidifies as a hard layer when the water cools down. All the impurities collect below the layer of wax as a loose mass and they can be shaved off. The process may have to be repeated if there are further impurities. Pure fresh bees' wax is generally yellow in colour, but it can be bleached by exposing it to the sun in thin sheets for two or three days. It was found that the quantity of wax extracted by this method weighed nearly 25 per cent of the total weight of the combs.

APPENDIX II.

There is a fairly well-equipped Apiary of the Indian bee under the Government Entomologist, Agricultural Research Institute, Lawley Road P.O. and he will be glad to provide the necessary help, advice, appliances, etc., for enthusiasts who wish to start this fascinating industry either as a hobby or as a paying cottage industry. Practical training in the subject will be given free of cost and the total period of training may last from two to three weeks.

The following are the appliances necessary to start and maintain a small apiary successfully:—

(1) Bee-hives with supers—six.
(2) Honey-extractor—one.
(3) Porter bee-escapes—six.
(4) Swarm-traps—six.
(5) Comb foundation sheet—1 lb.

The prices of these equipments have considerably increased now and as the market is still unsteady, it is not possible to furnish a definite price list of the above. The Government Entomologist will, however, arrange for the supply of the appliances at the lowest possible rates.

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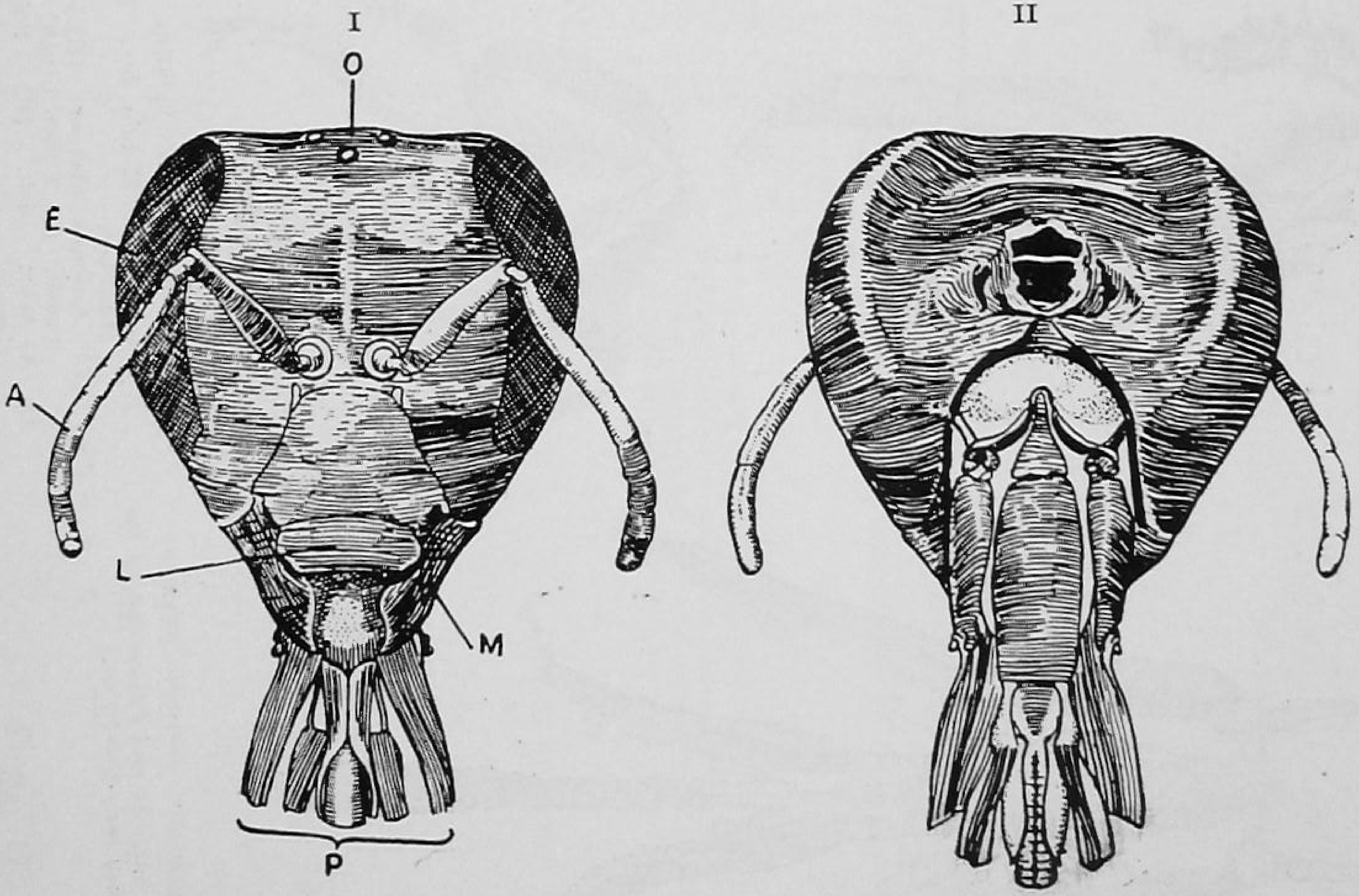

FIG. 1.—HEAD OF WORKER BEE

I. Anterior view. II. Posterior view.

(A) Antenna. (E) Eyes. (L) Labrum. (M) Mandibles. (O) Ocelli. (P) Proboscis (cut off).

(*Reprint from Anatomy and Physiology of the Honey-bee—Snodgrass.*)

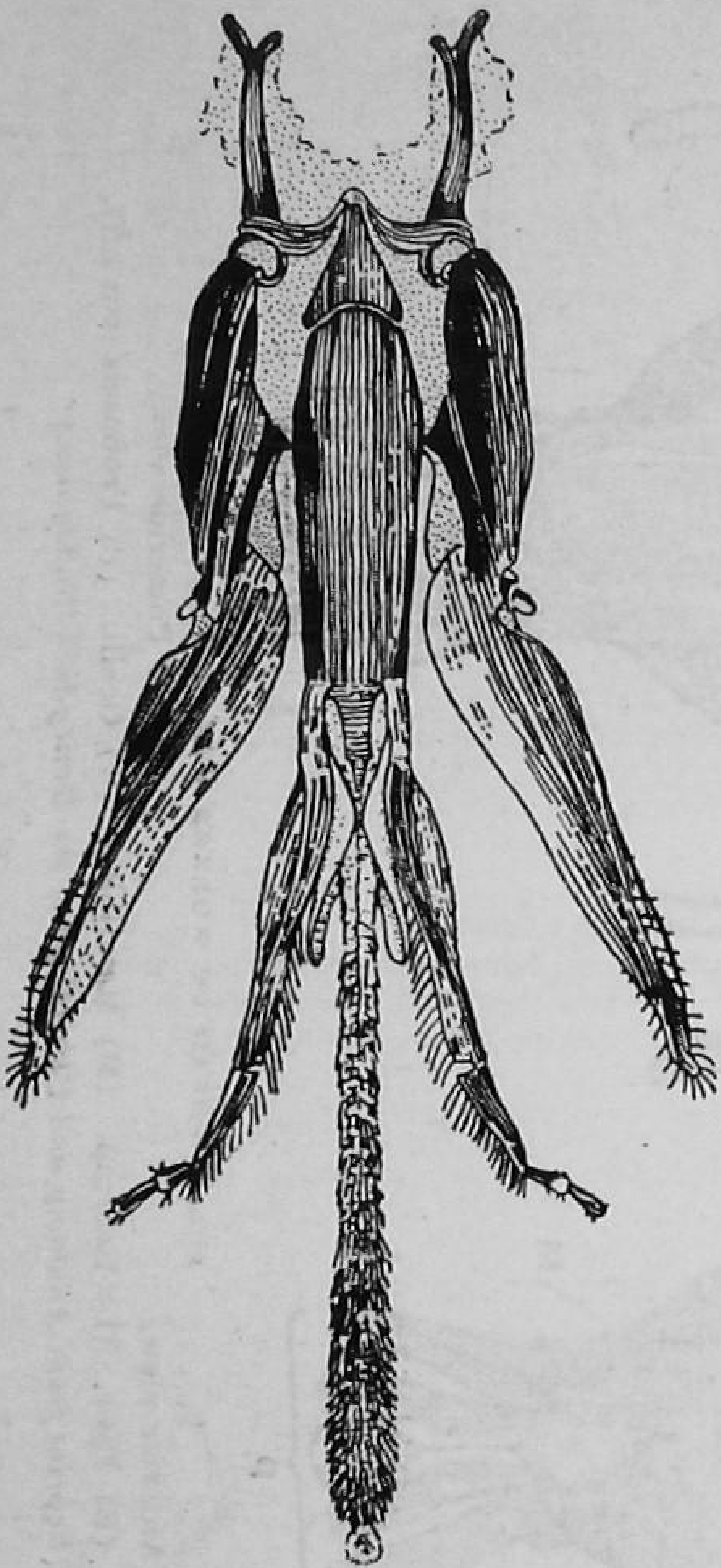

FIG. 2.—PROBOSCIS—SHOWING DETAILS

(*Reprint from Anatomy and Physiology of the Honey-bee—Snodgrass.*)

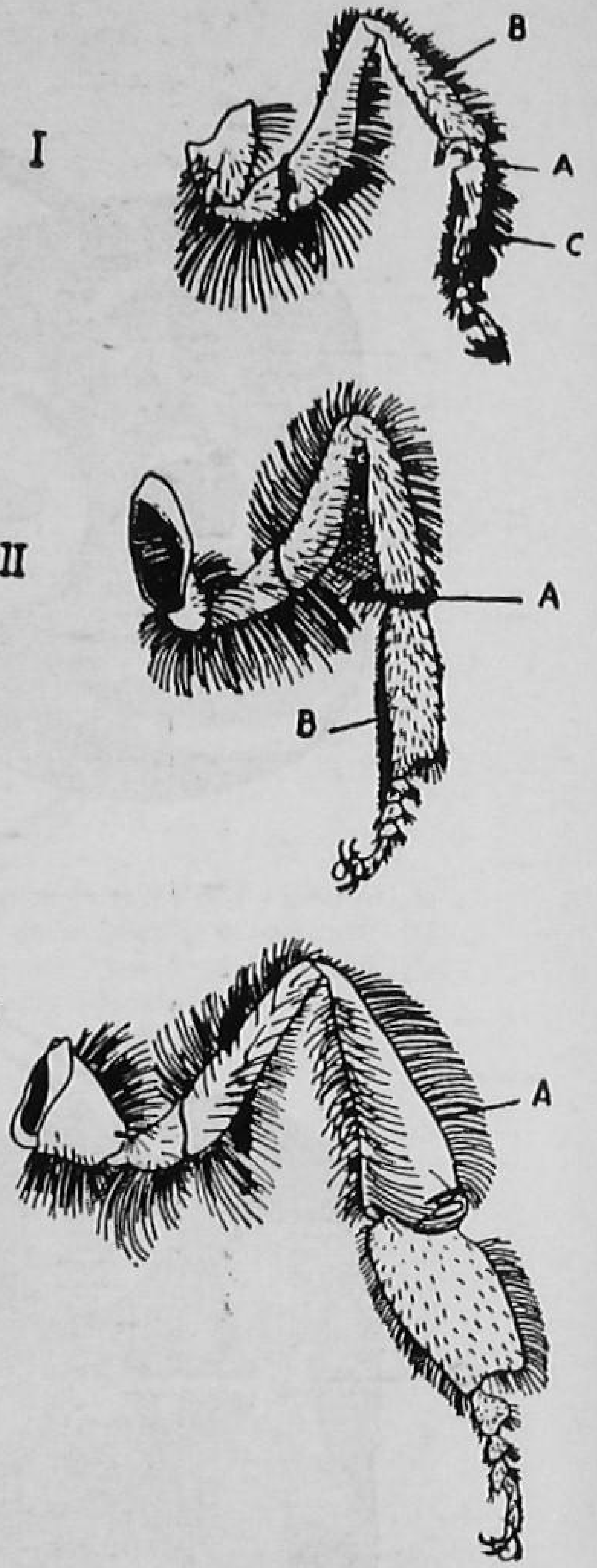

FIG. 3.—LEGS OF THE WORKER

I. Foreleg. II. Middle leg. III. Hind leg.
I. (A) Antenna cleaner. (B) Eye brush. (C) Pollen brush.
II. (A) Wax pick. (B) Pollen brush.
III. (A) Pollen basket.

(*Reprint from Anatomy and Physiology of the Honey-bee—Snodgrass.*)

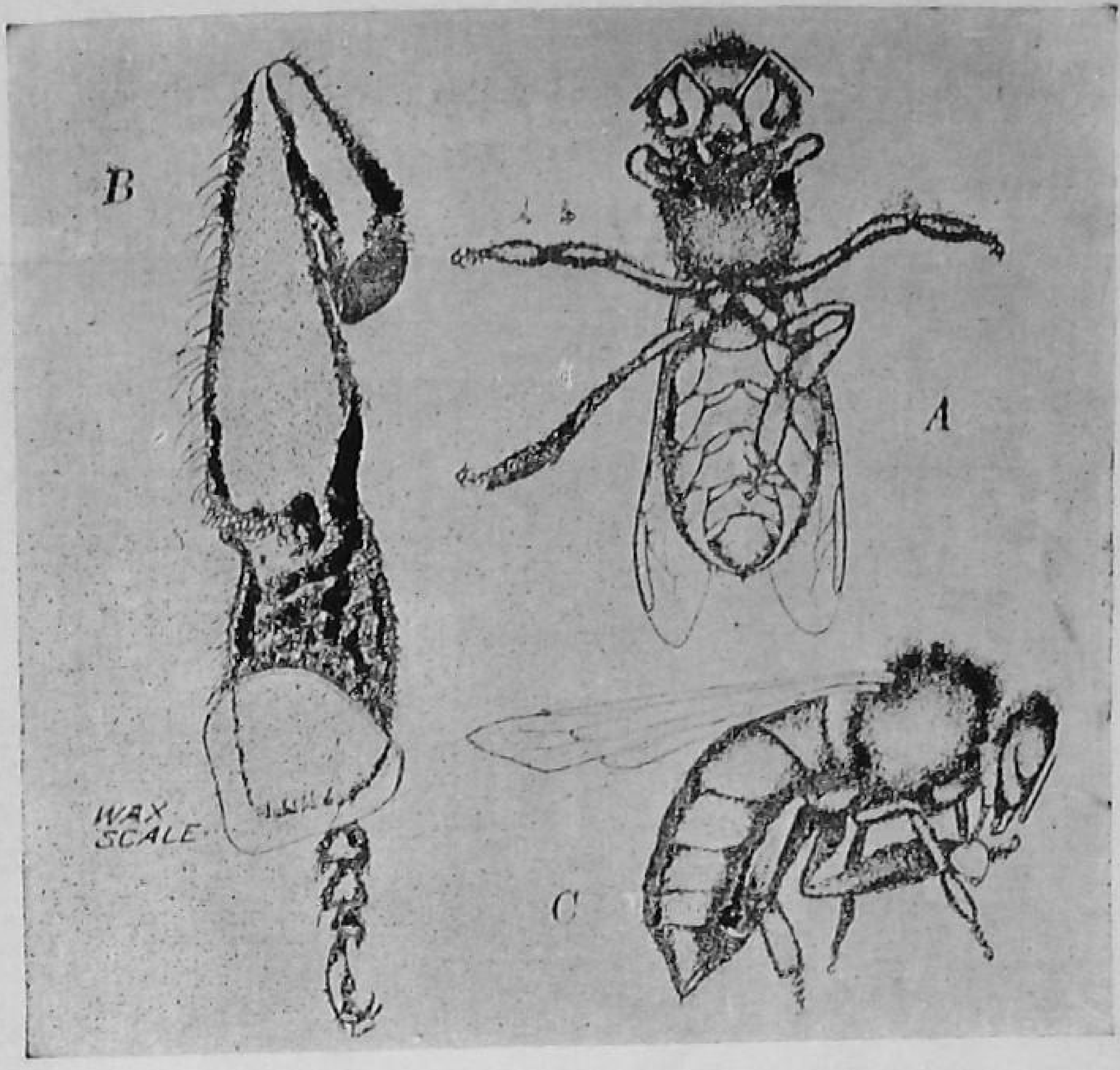

FIG. 4.

(*A*) Worker bee removing a wax scale from abdomen.
(*B*) Wax scale immediately after it has been removed from the wax pocket.
(*C*) Wax scale being grasped by the fore-legs and mandibles for being moulded into the required shape (After D.B. Casteel.)

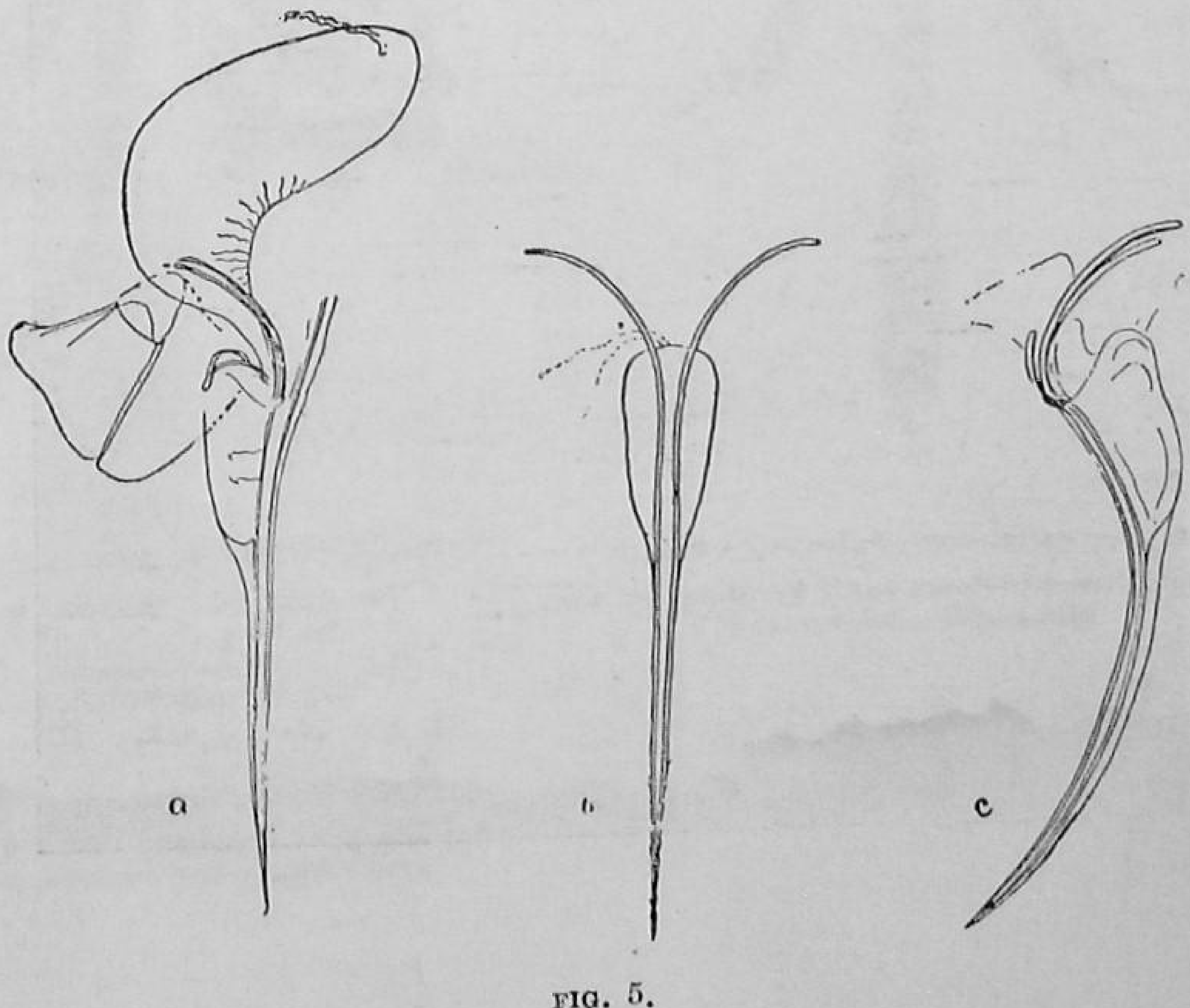

FIG. 5.

(*a*) Sting of worker (lateral view).
(*b*) Front view of same showing the barbs.
(*c*) Sting of queen.

FIG. 6.—A HONEY-WEEK EXHIBITION

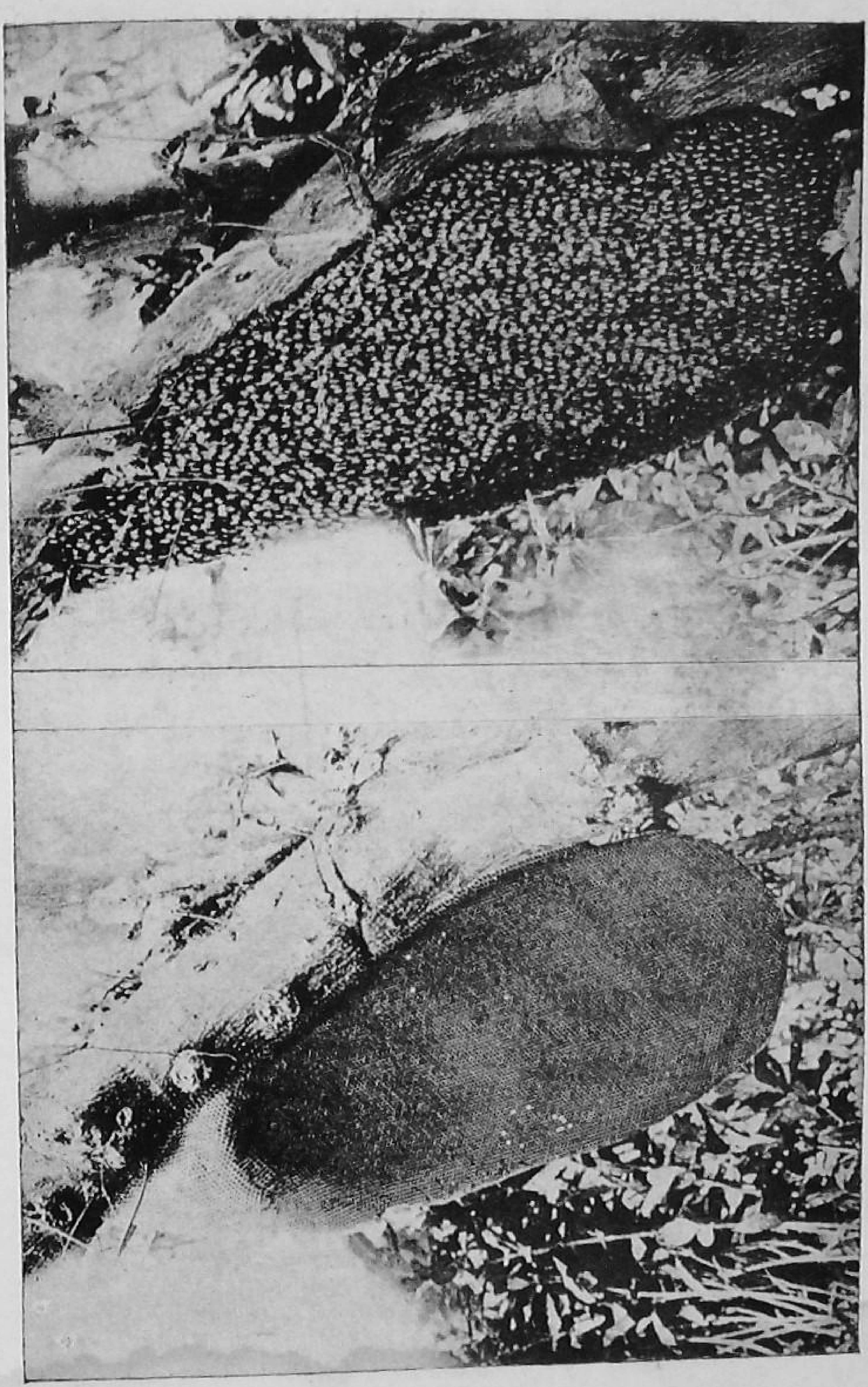

FIG. 7.—COMB OF THE ROCK BEE—WITH AND WITHOUT BEES
(*Reprint from the Agricultural Zoology of the Malay Archipilago*
—*Dammerman, K. W.*)

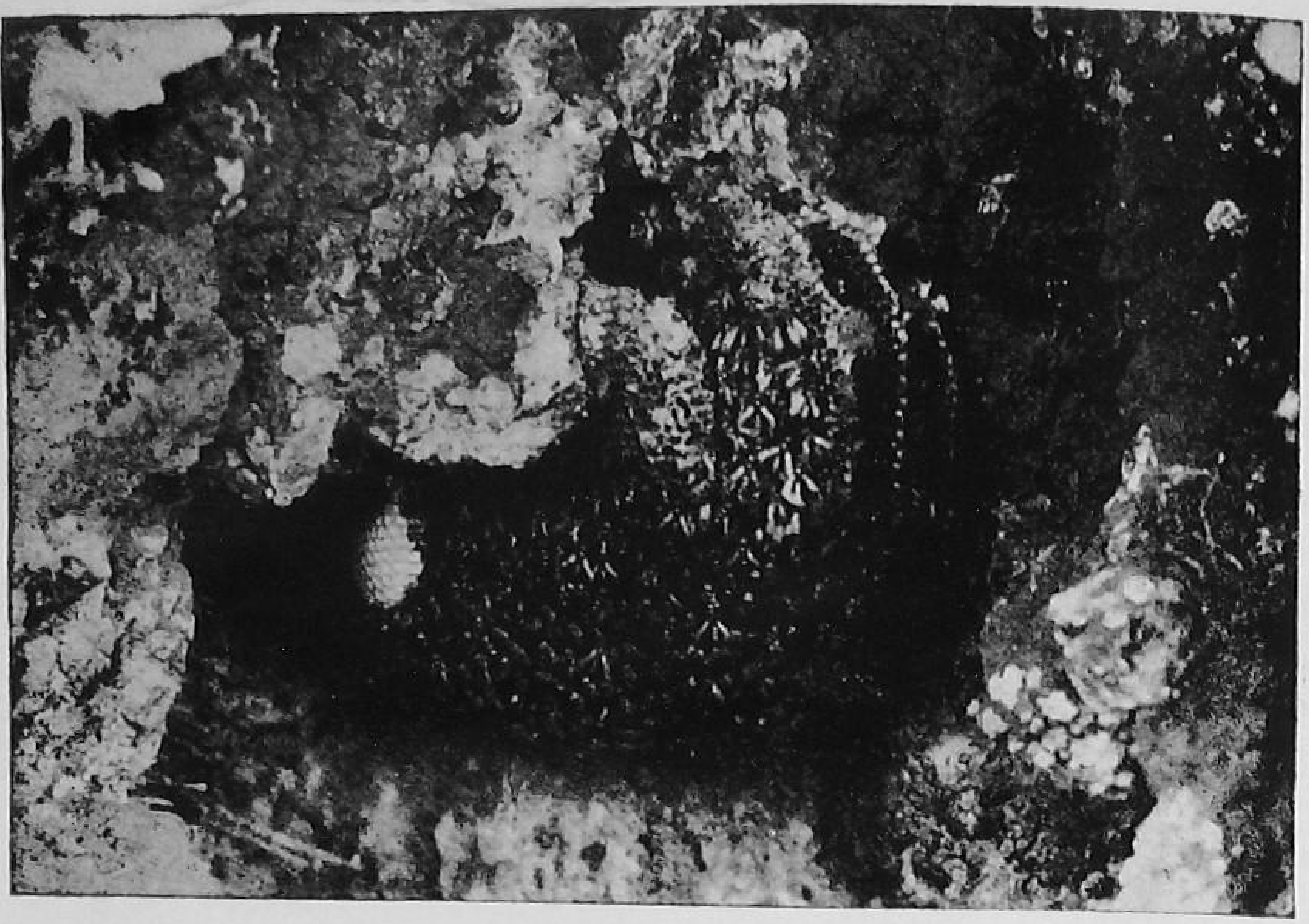

FIG. 8.—WILD COLONY OF A. INDICA

FIG. 9.—COLONY OF A. FLOREA

THE SAME WITHOUT BEES SHOWING DRONE AND WORKER BROOD.

(*Reprint from Pusa Bull, No. 46—C. C. Ghosh.*)

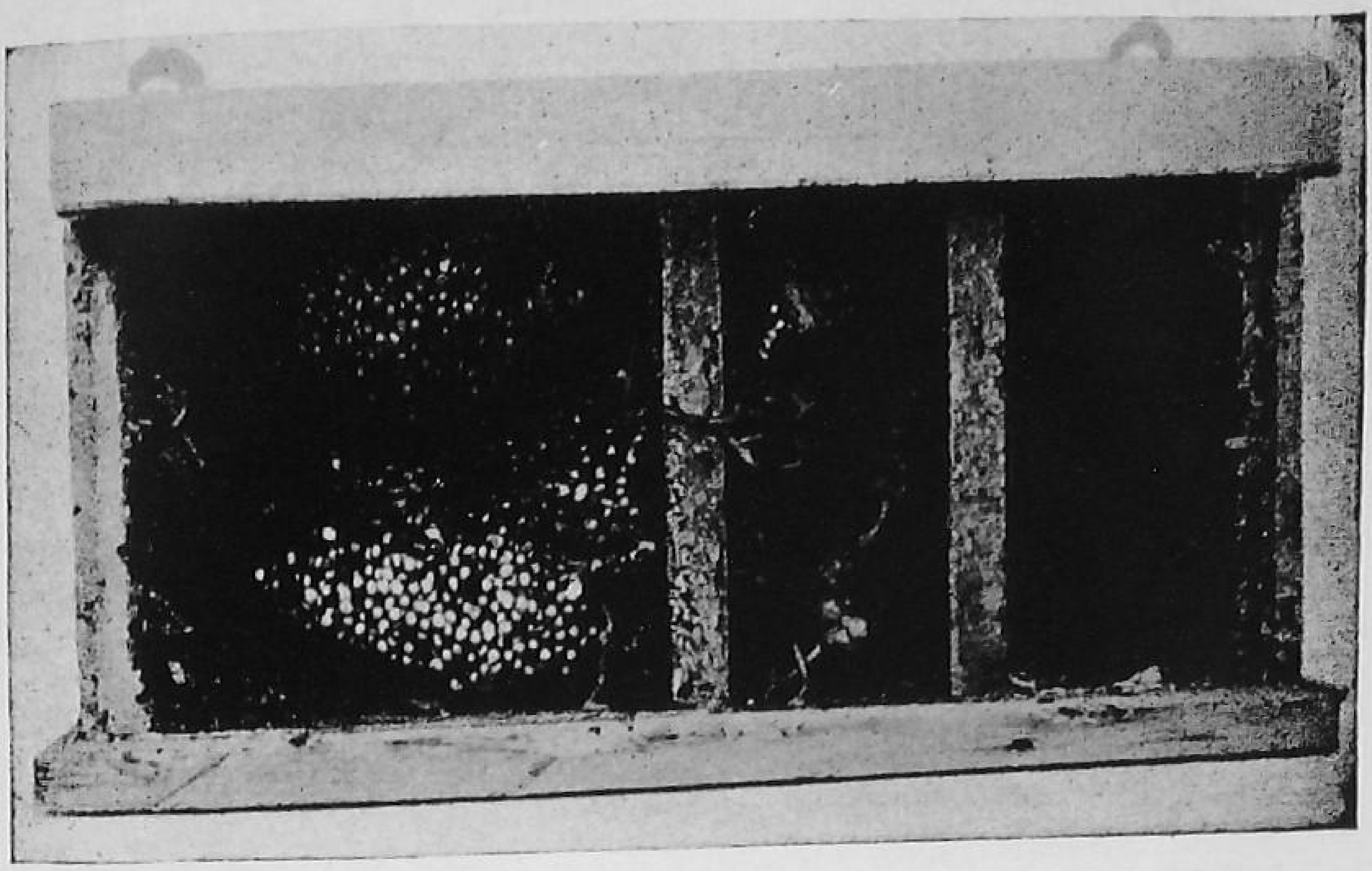

FIG. 10.—A COLONY OF THE MELIPONA BEE

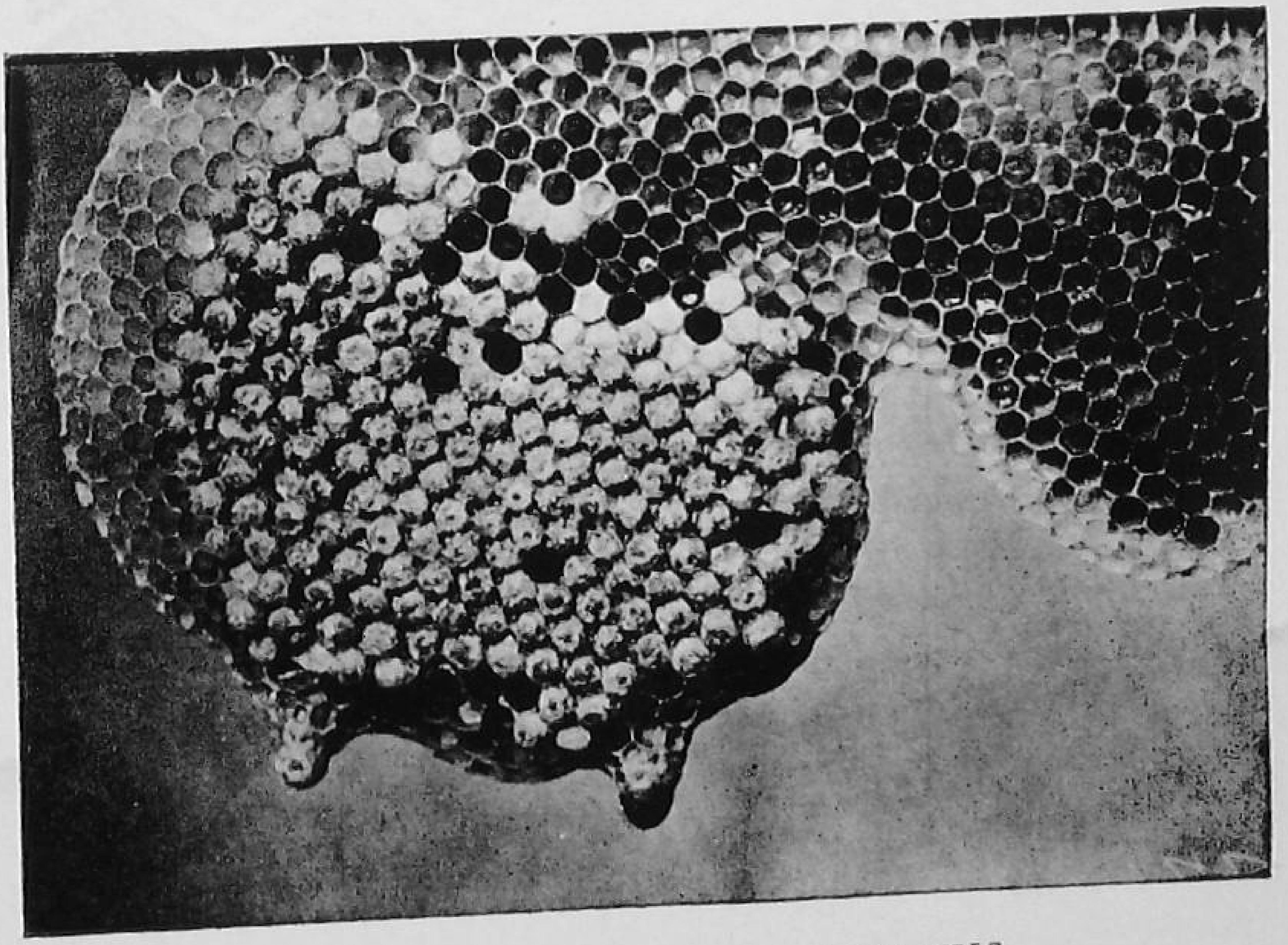

FIG. 11.—DRONE-BROOD AND QUEEN CELLS

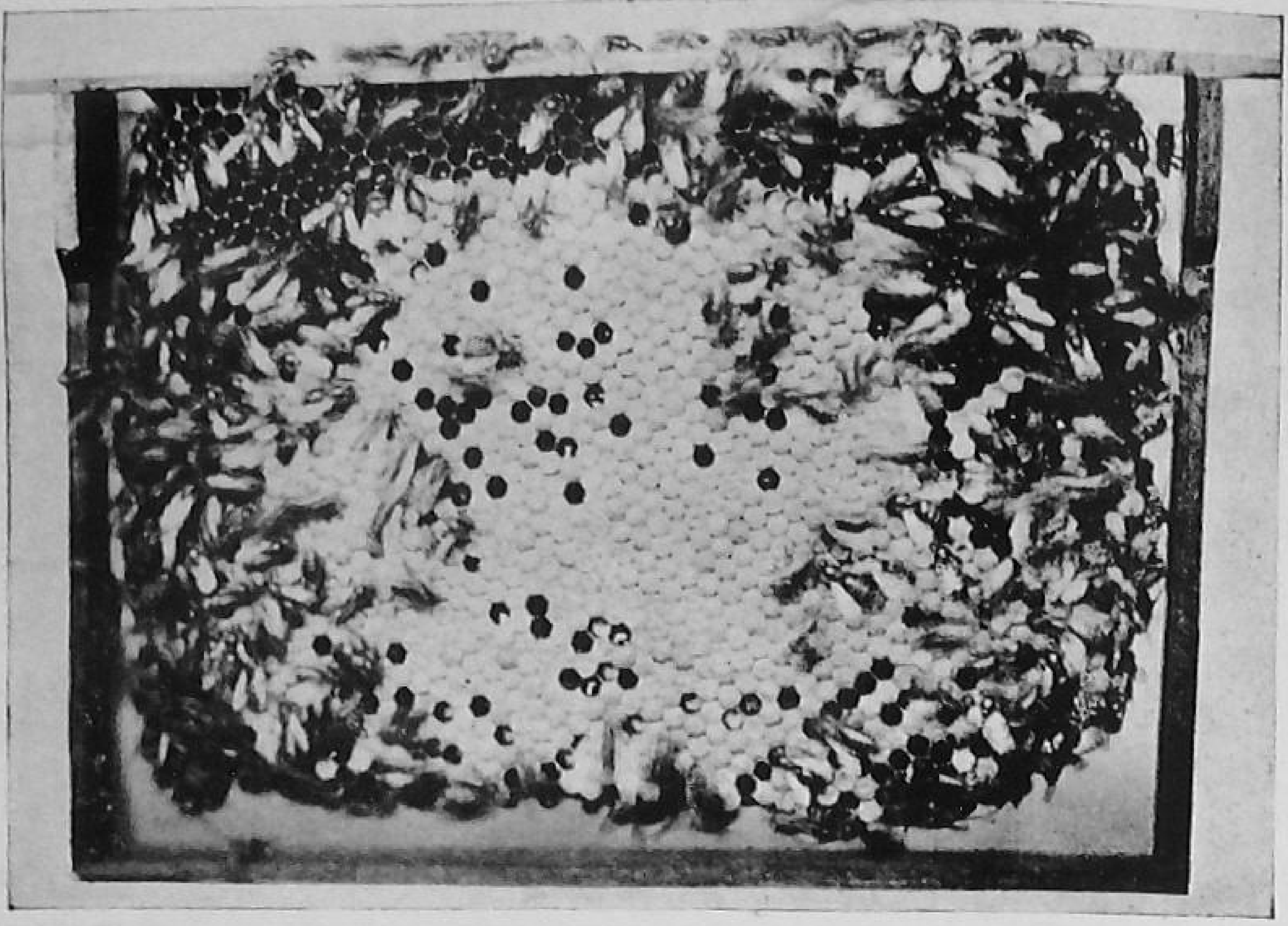

FIG. 12.—WELL-SEALED WORKER BROOD.

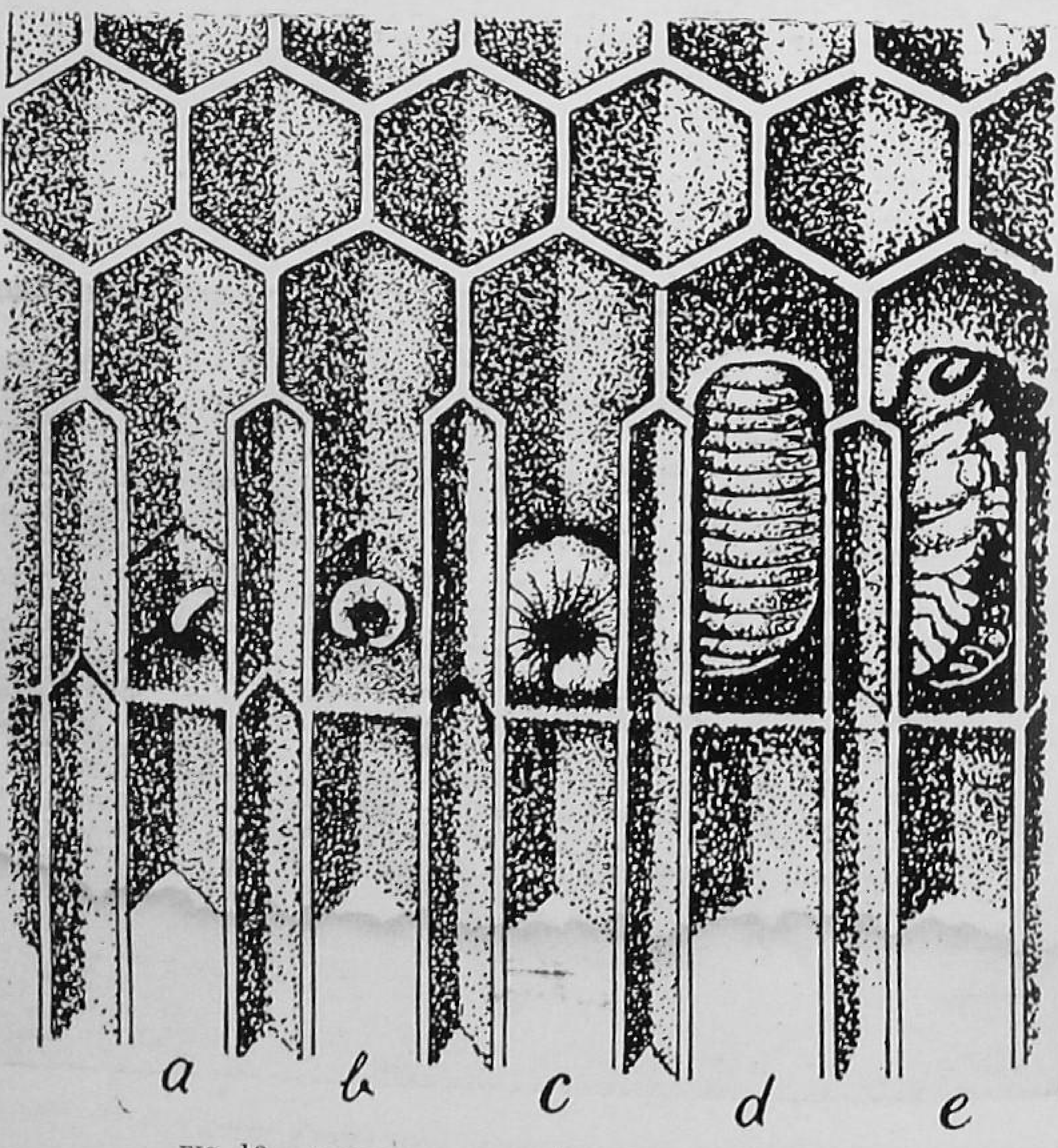

FIG. 13.—DEVELOPMENT OF THE BEE IN THE COMB

(a) Egg naturally laid at the bottom of the cell
(b) Young grub
(c) Full-grown grub
(d) Full-grown grub ready to pupate
(e) Pupa

(*Copy from Pusa Bull, No. 46—C. C. Ghosh.*)

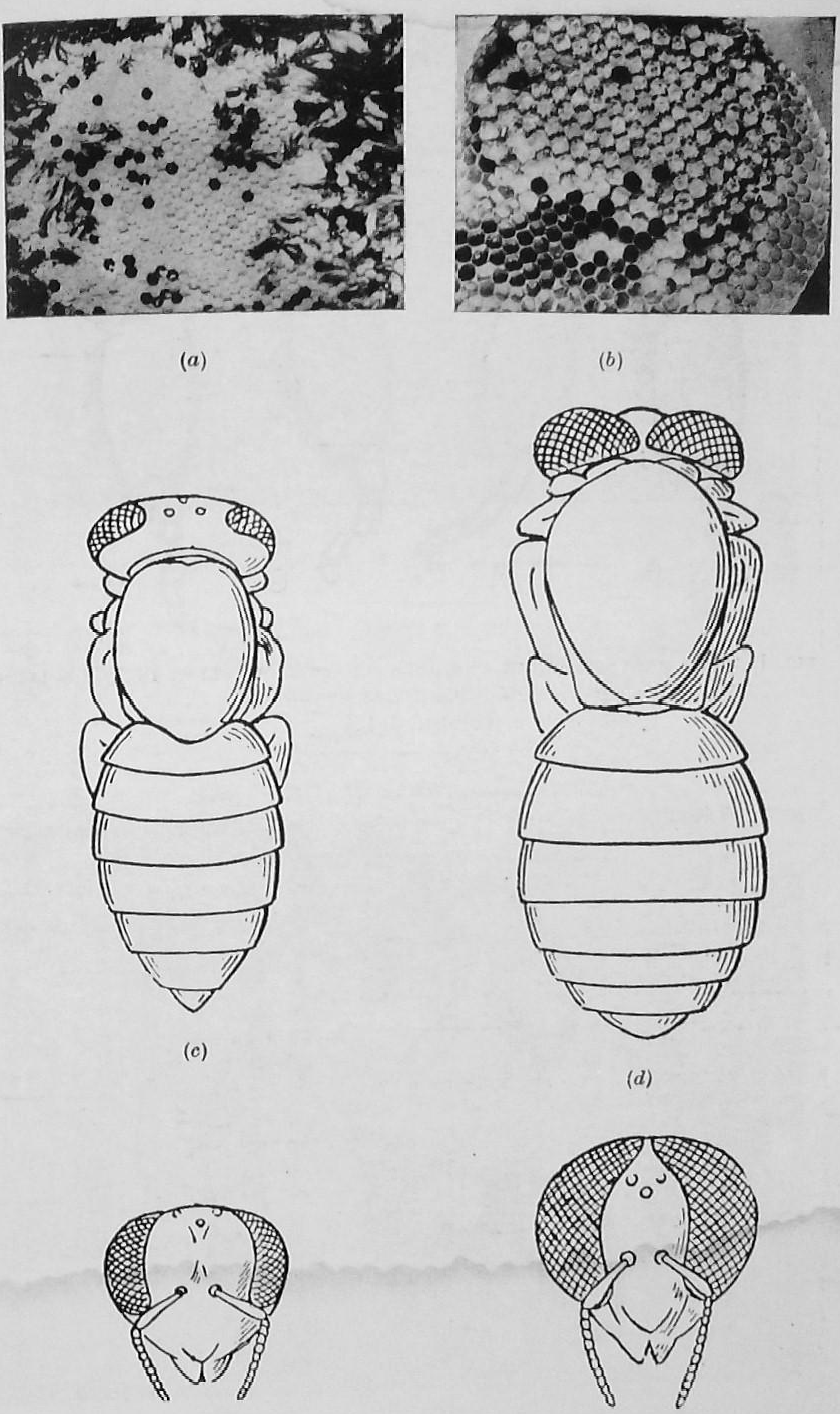

FIG. 14.—DIFFERENCE BETWEEN DRONE AND WORKER

(a) Capped worker-brood.
(b) Capped drone-brood.
(c) Worker pupa.
(d) Drone pupa.
(e) Front view of worker pupa.
(f) Front view of drone pupa.

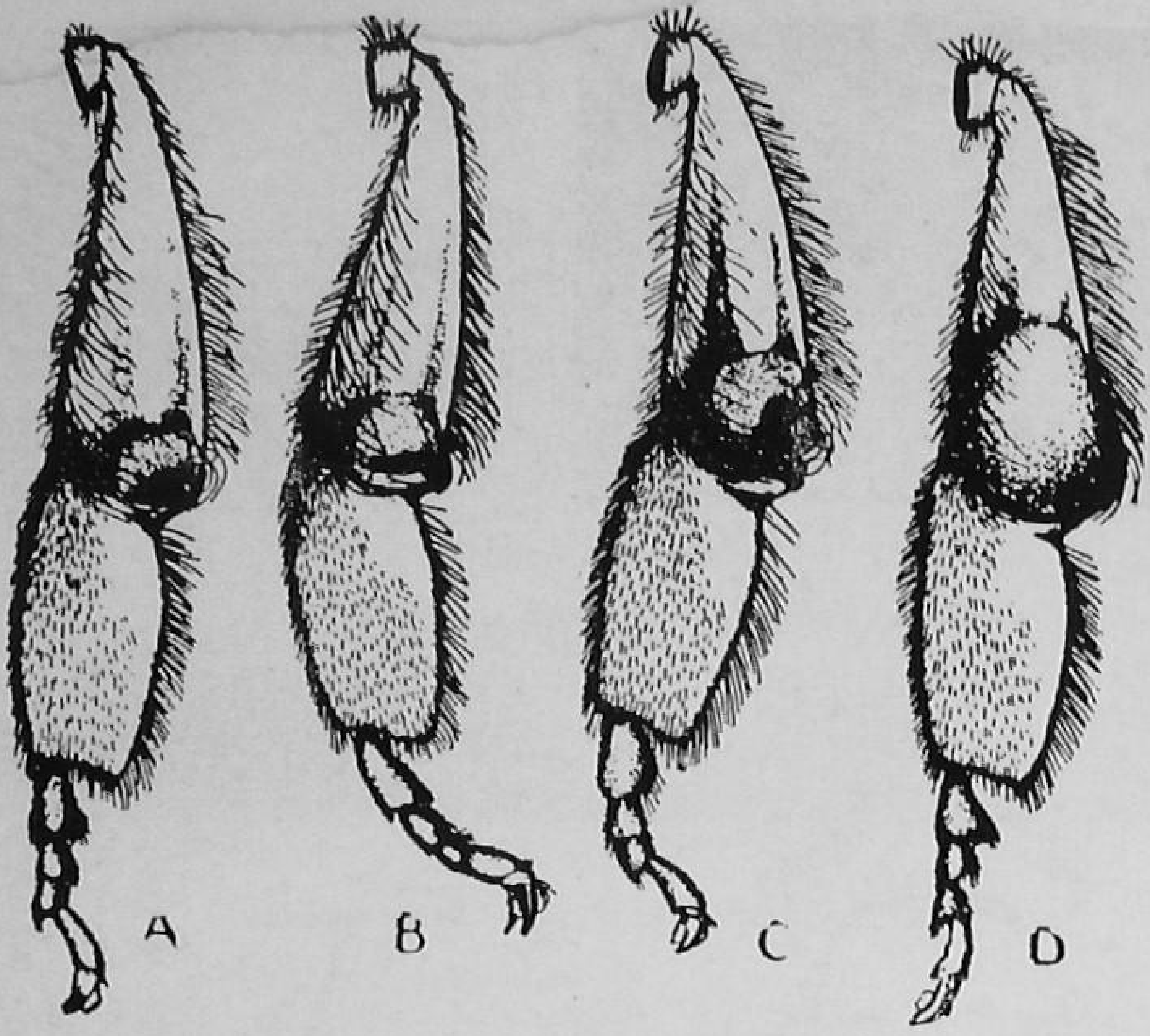

FIG. 15.—SUCCESSIVE STAGES IN THE ACCUMULATION OF POLLEN IN THE POLLEN BASKET BY ADDITION AT LOWER EDGE

(*Casteel*, 1912)

FIG. 16.—POLLEN MANIPULATION

(*A*) Flying bee manipulating pollen.
(*B*) Flying bee packing pollen.
(*C*) Hind leg bearing a complete load of pollen.

(*After D. B. Casteel*)

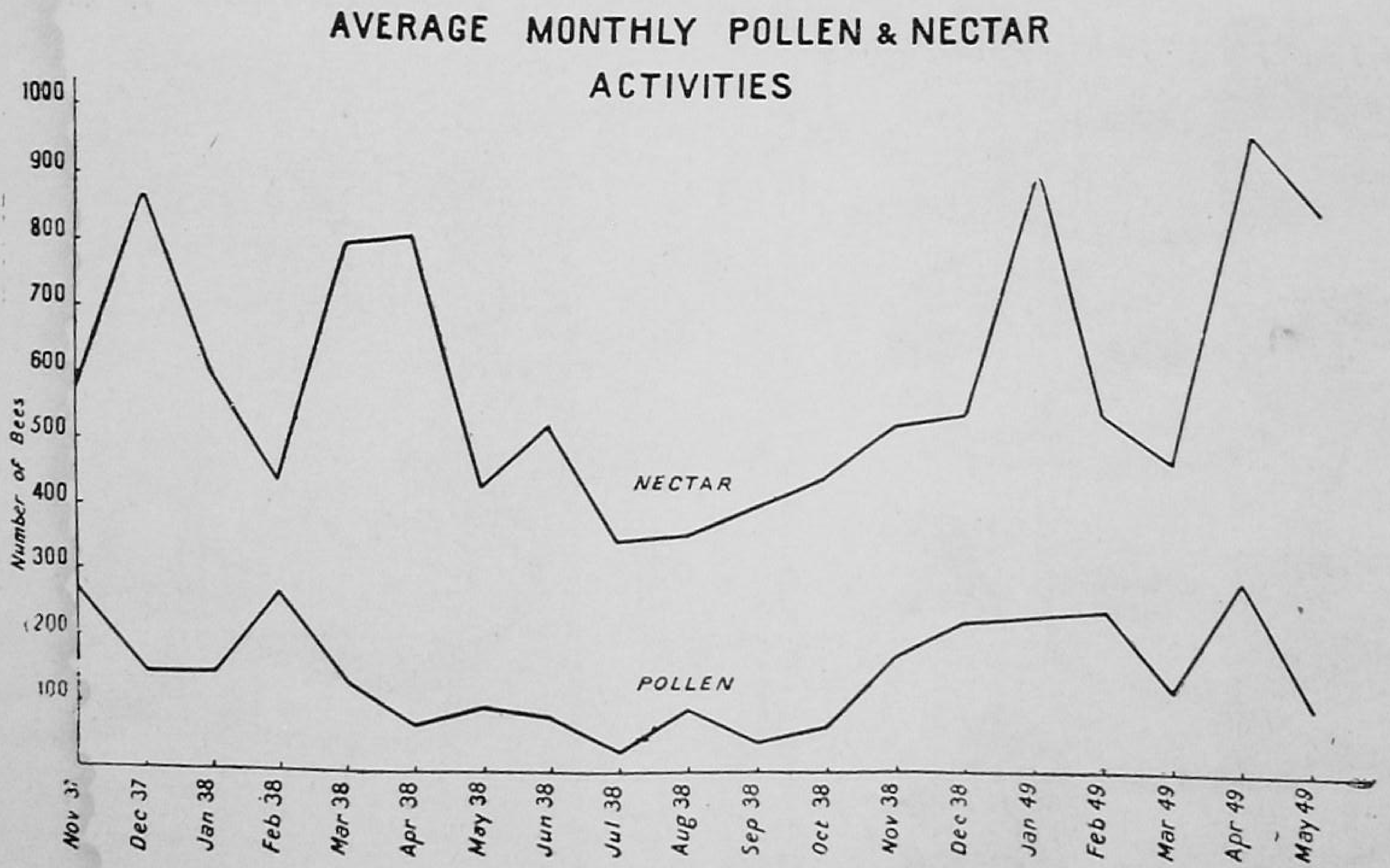

FIG. 17.—AVERAGE MONTHLY POLLEN AND NECTAR ACTIVITIES

FIG. 18.—EXPELLED DRONES

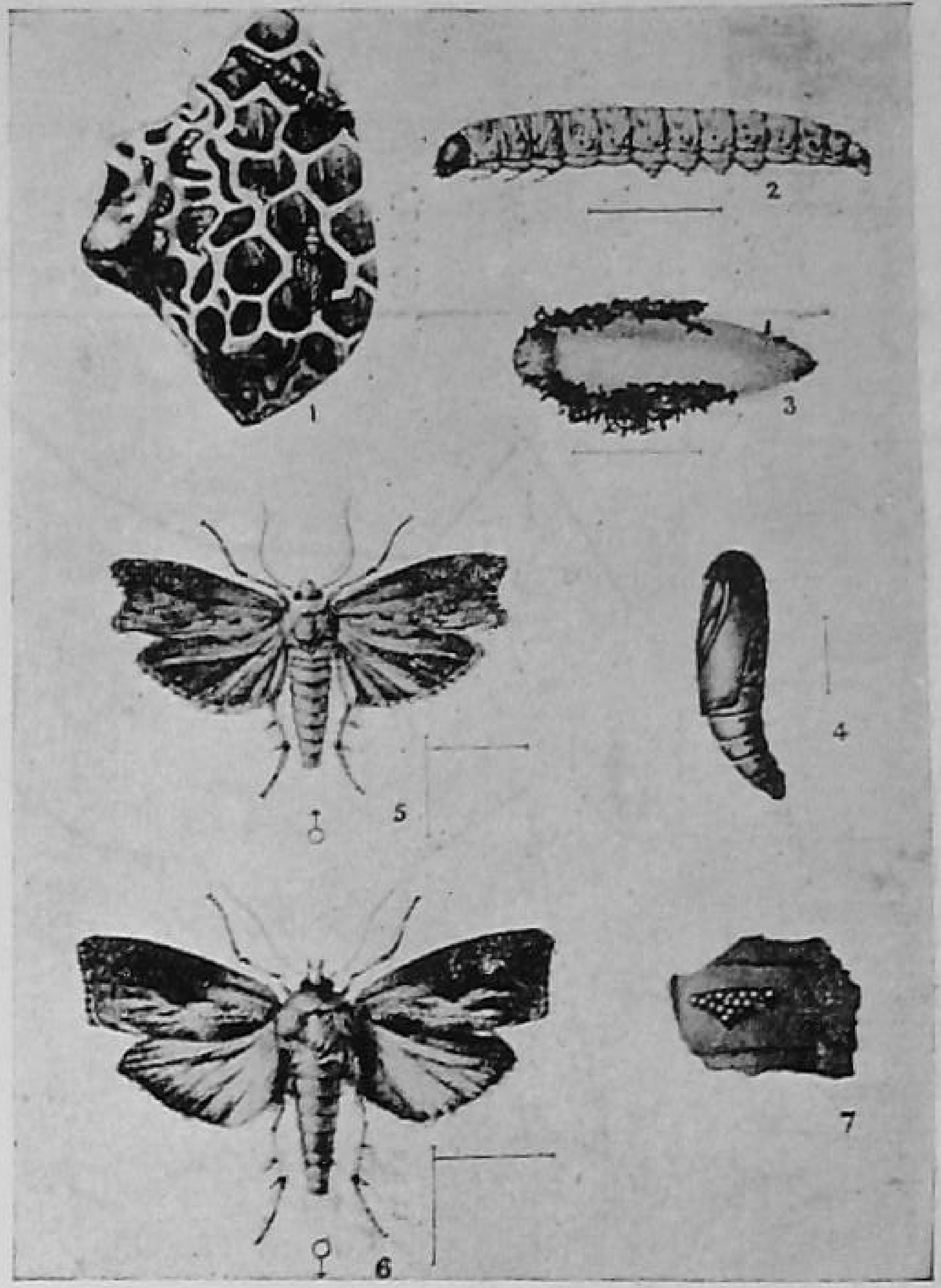

FIG. 19—WAX MOTH

(Reprint from A.J.I.—Vol. VI.—Pt. 6—Fletcher.)

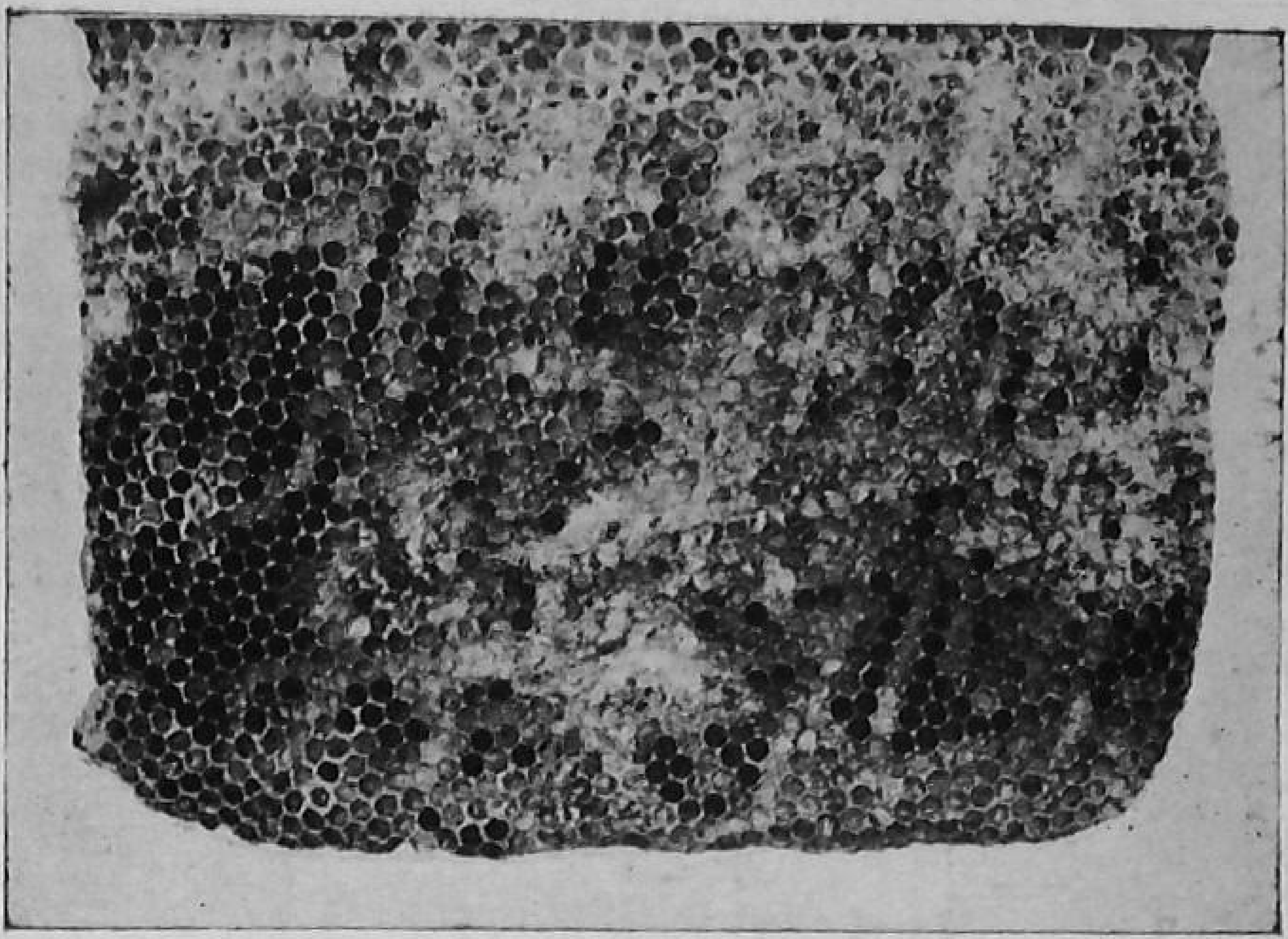

FIG. 20.—WAX-MOTH DAMAGE—ADVANCED STAGE

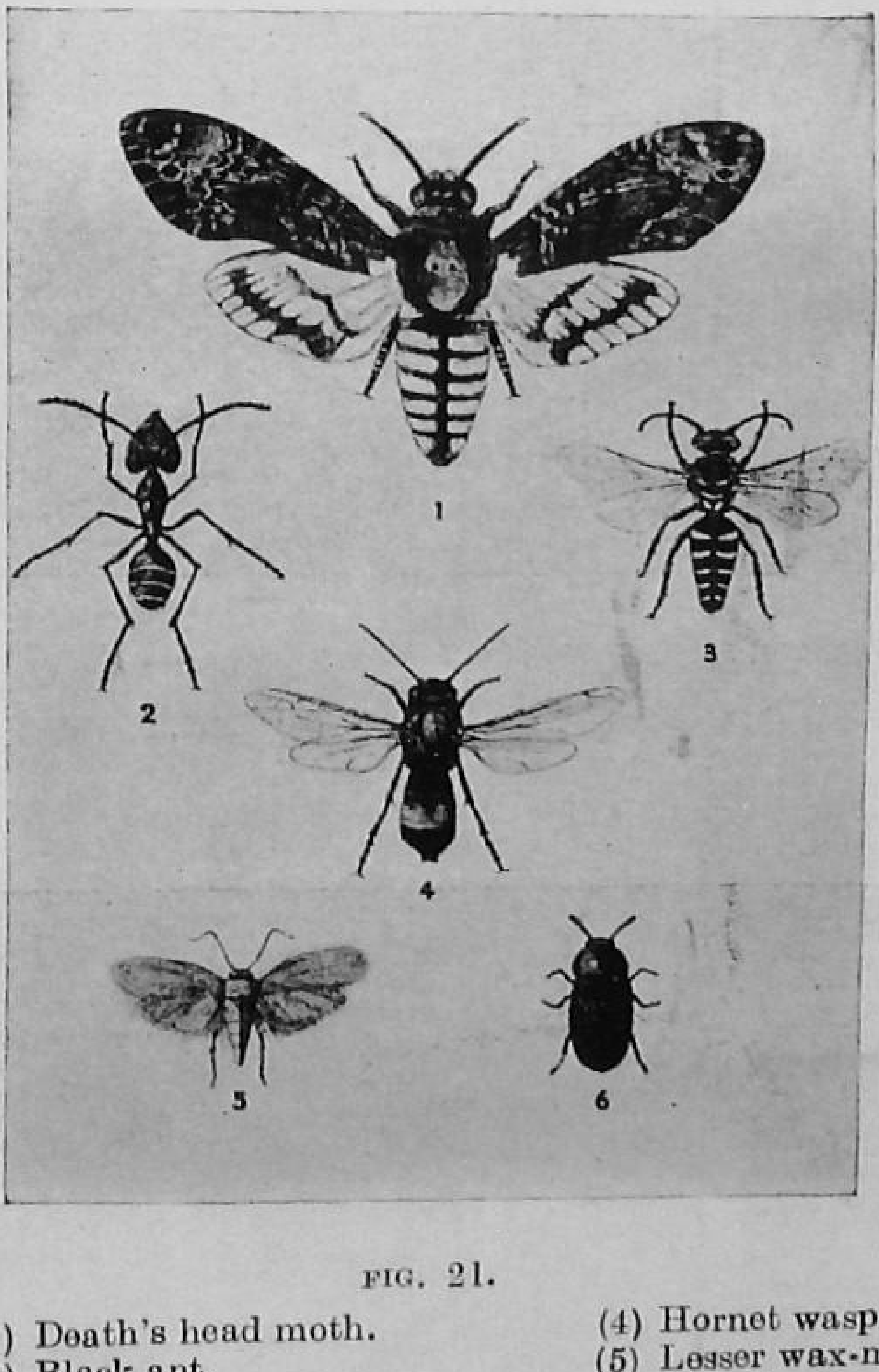

FIG. 21.

(1) Death's head moth.
(2) Black ant.
(3) Bee-hunter wasp.
(4) Hornet wasp.
(5) Lesser wax-moth.
(6) Wax beetle.

C

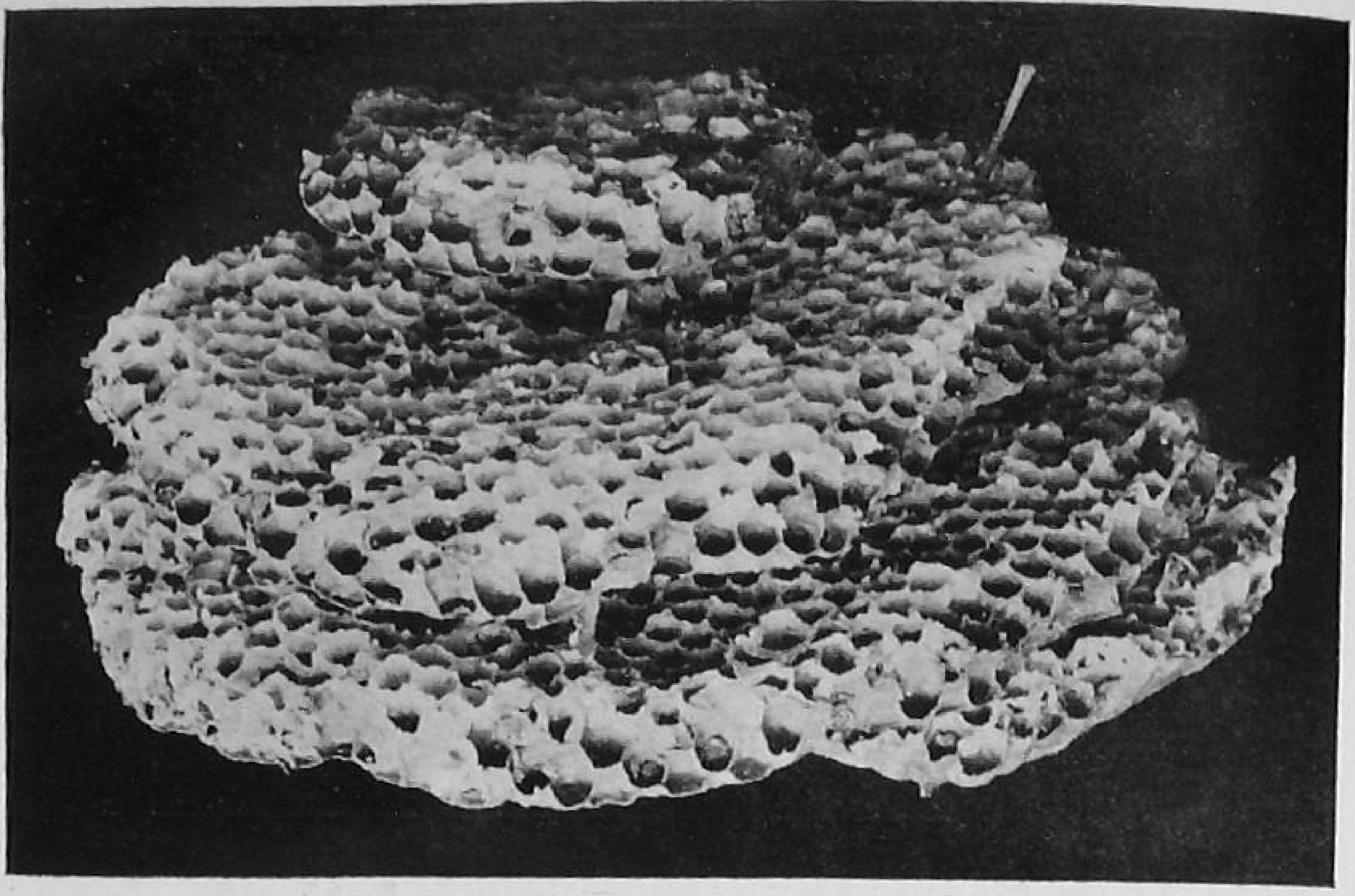

FIG. 22.—COMB OF HORNET WASP

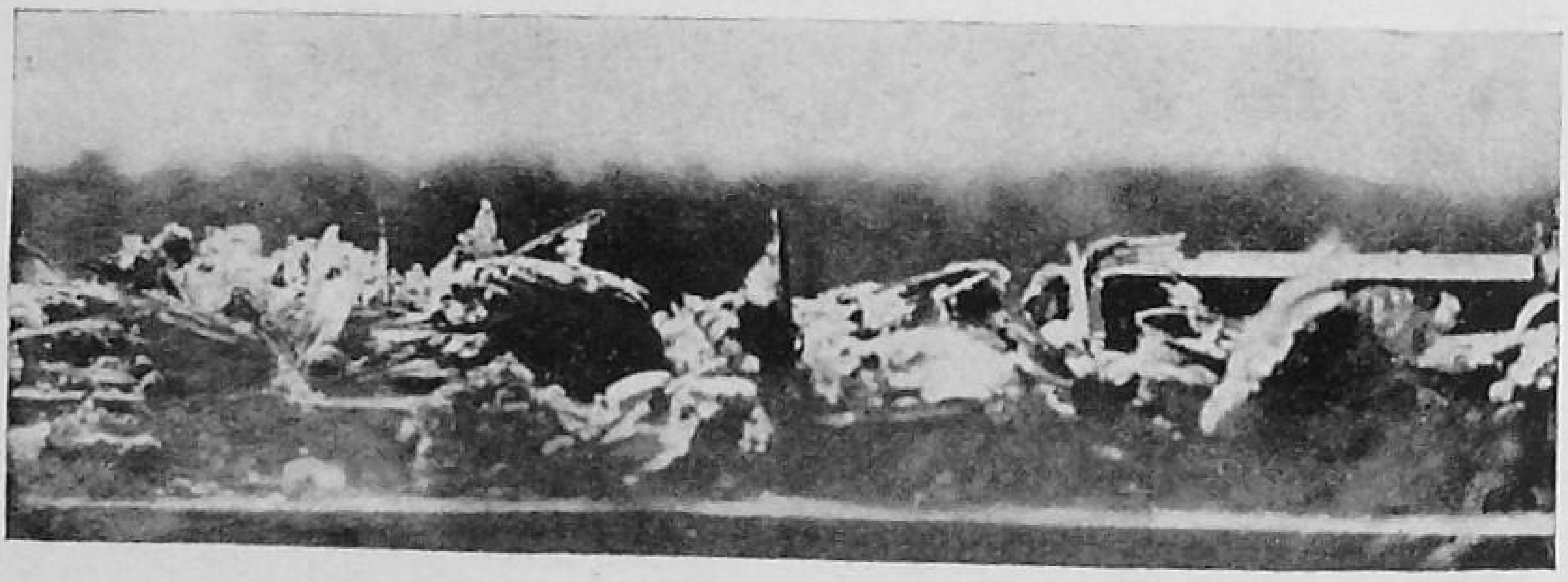

FIG. 23.—DEATH'S HEAD MOTHS FOUND DEAD IN A WILD COLONY

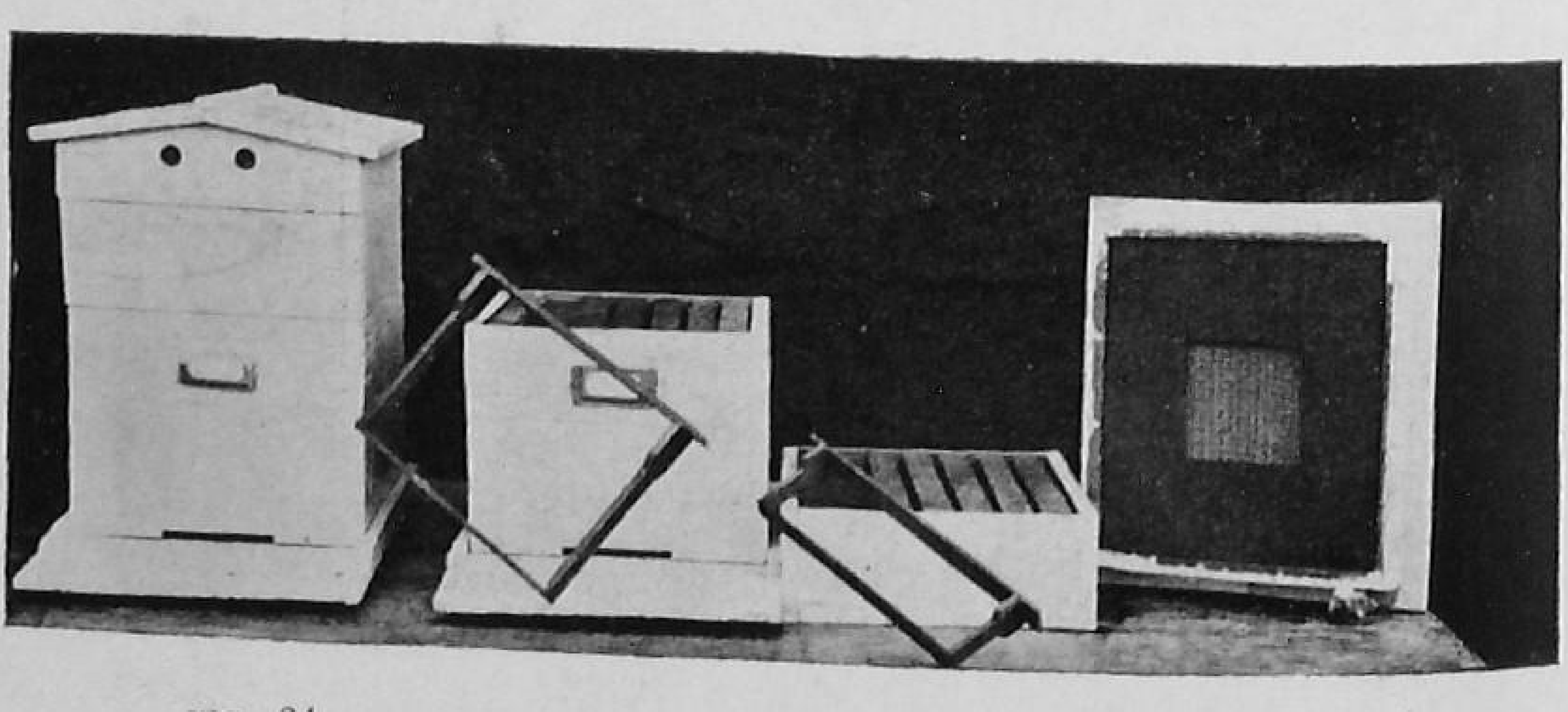

FIG. 24.—THE NEWTON BEE-HIVE AND ITS DIFFERENT PARTS

FIG. 25.—FIXING A COMB WITH PLANTAIN FIBRE

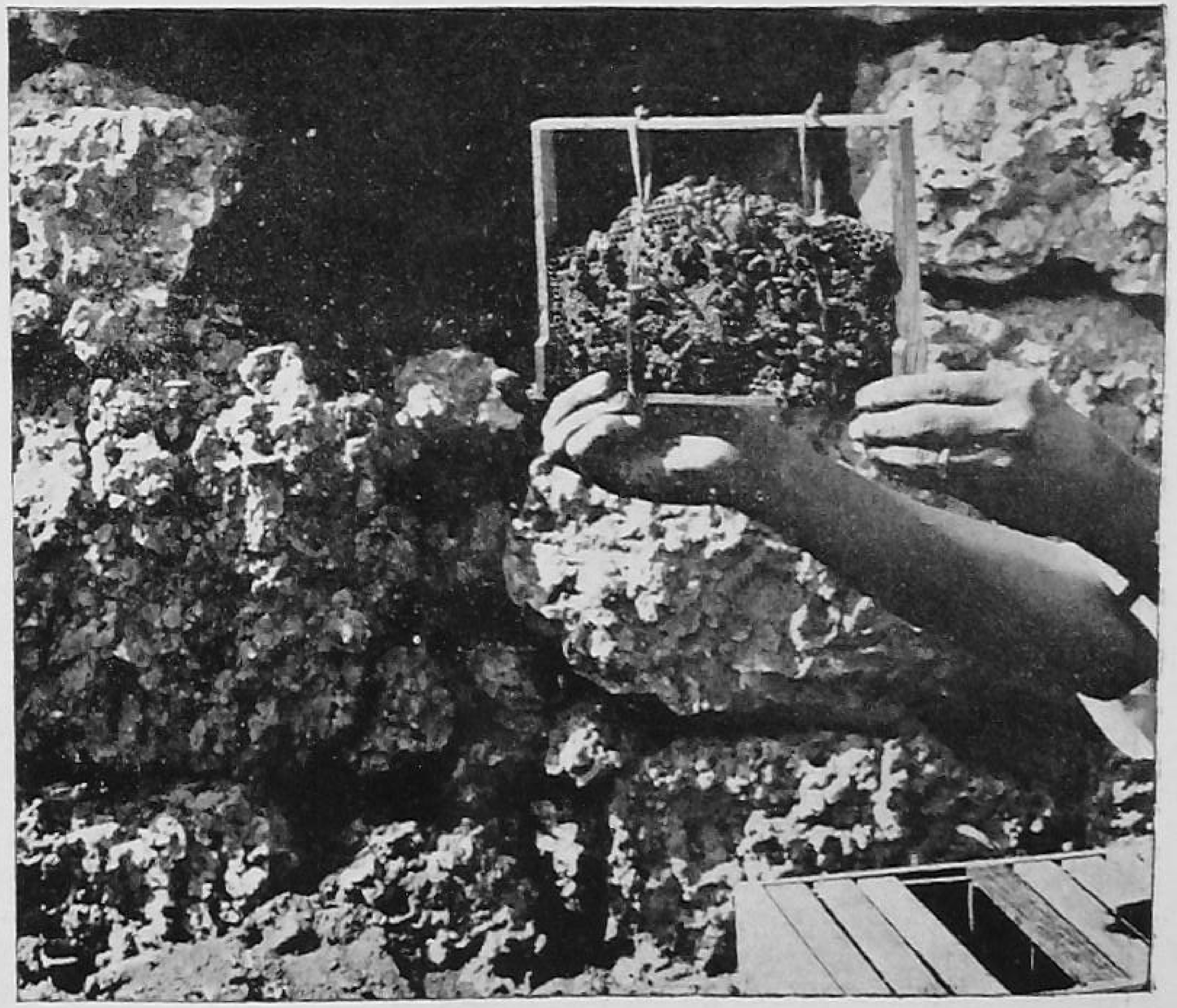

FIG. 26.—COMB FIXED

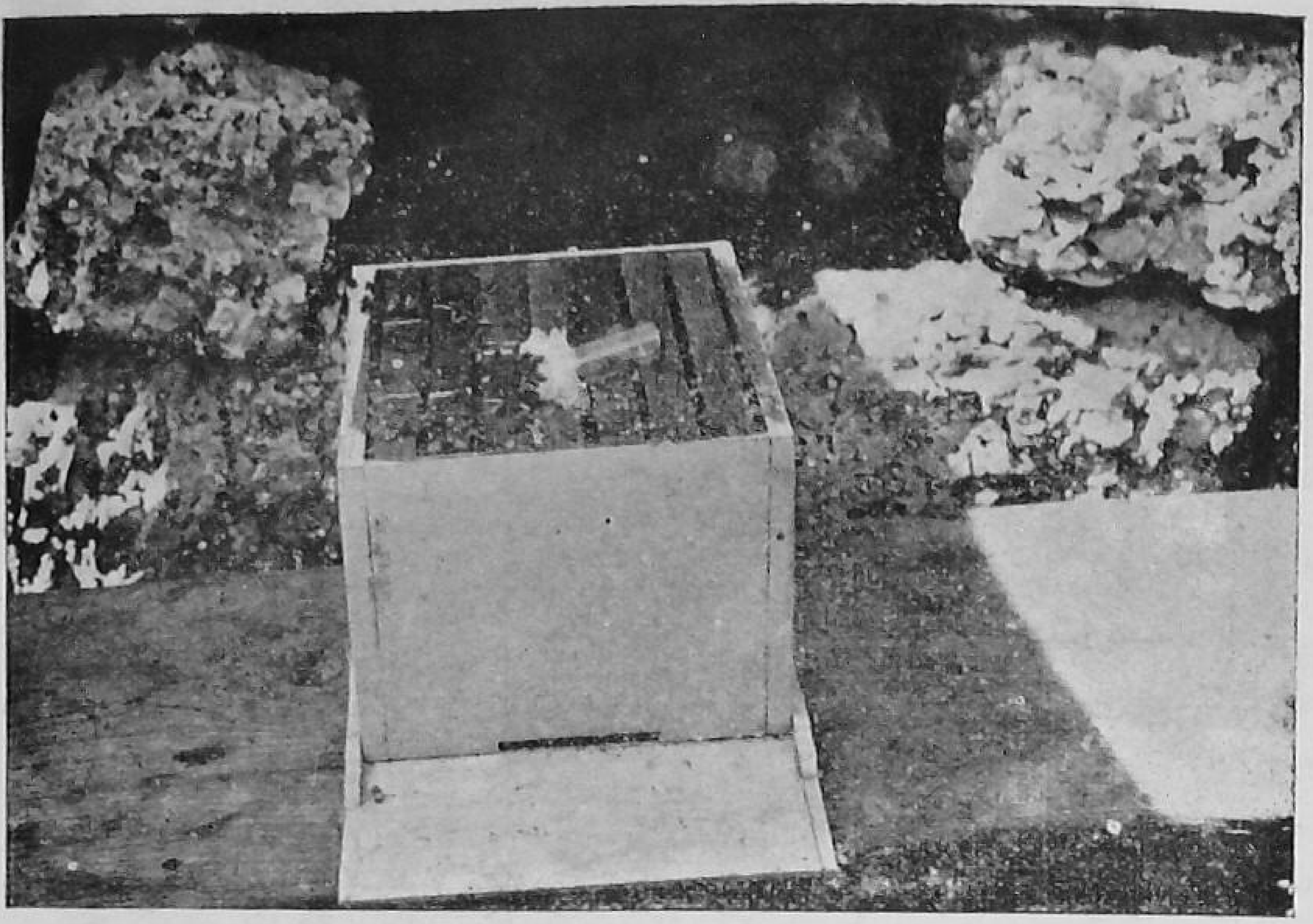

FIG. 27.—QUEEN CAGED BEFORE HIVING

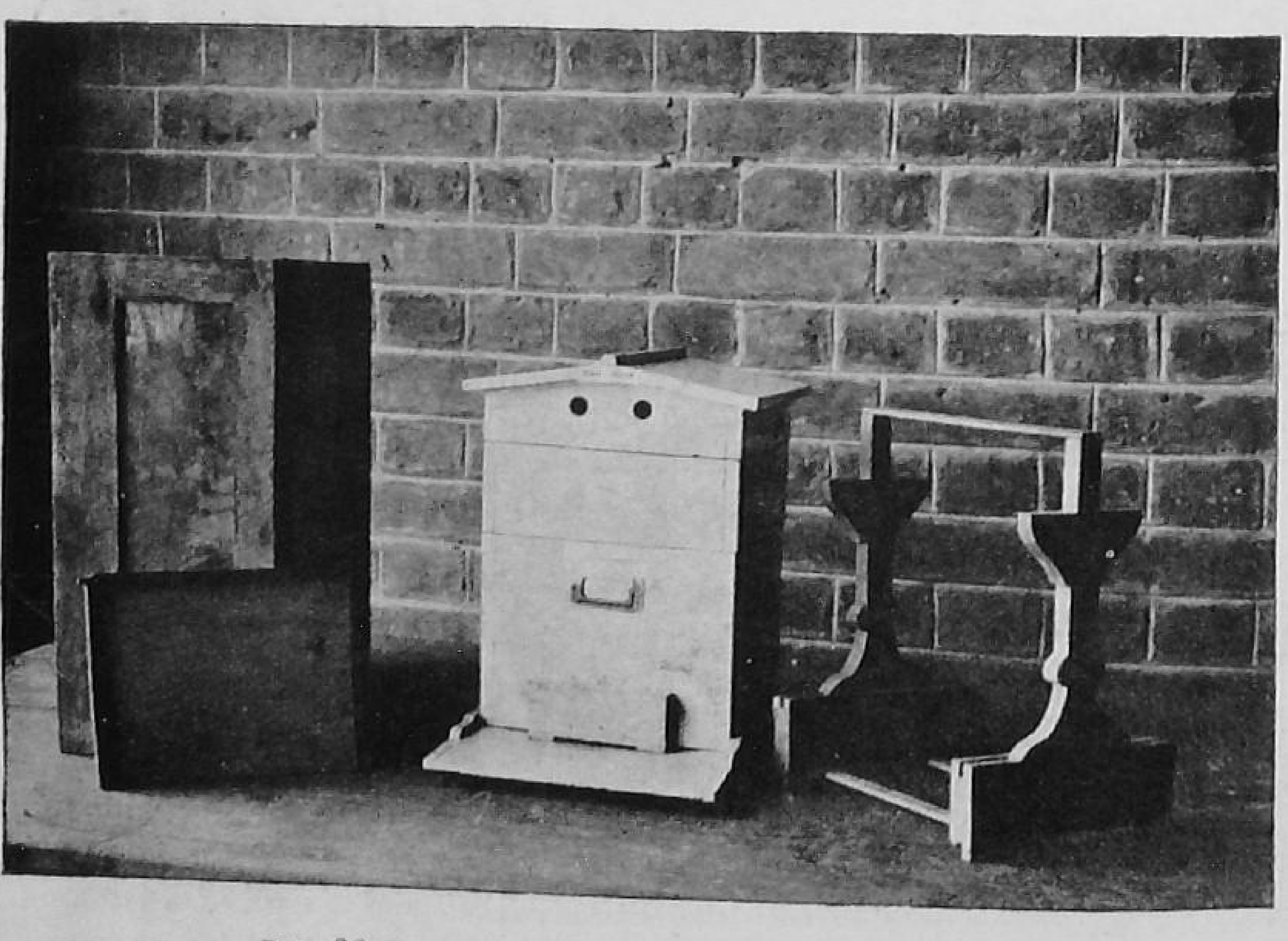

FIG. 28.—A BEE HIVE AND SOME ACCESSORIES

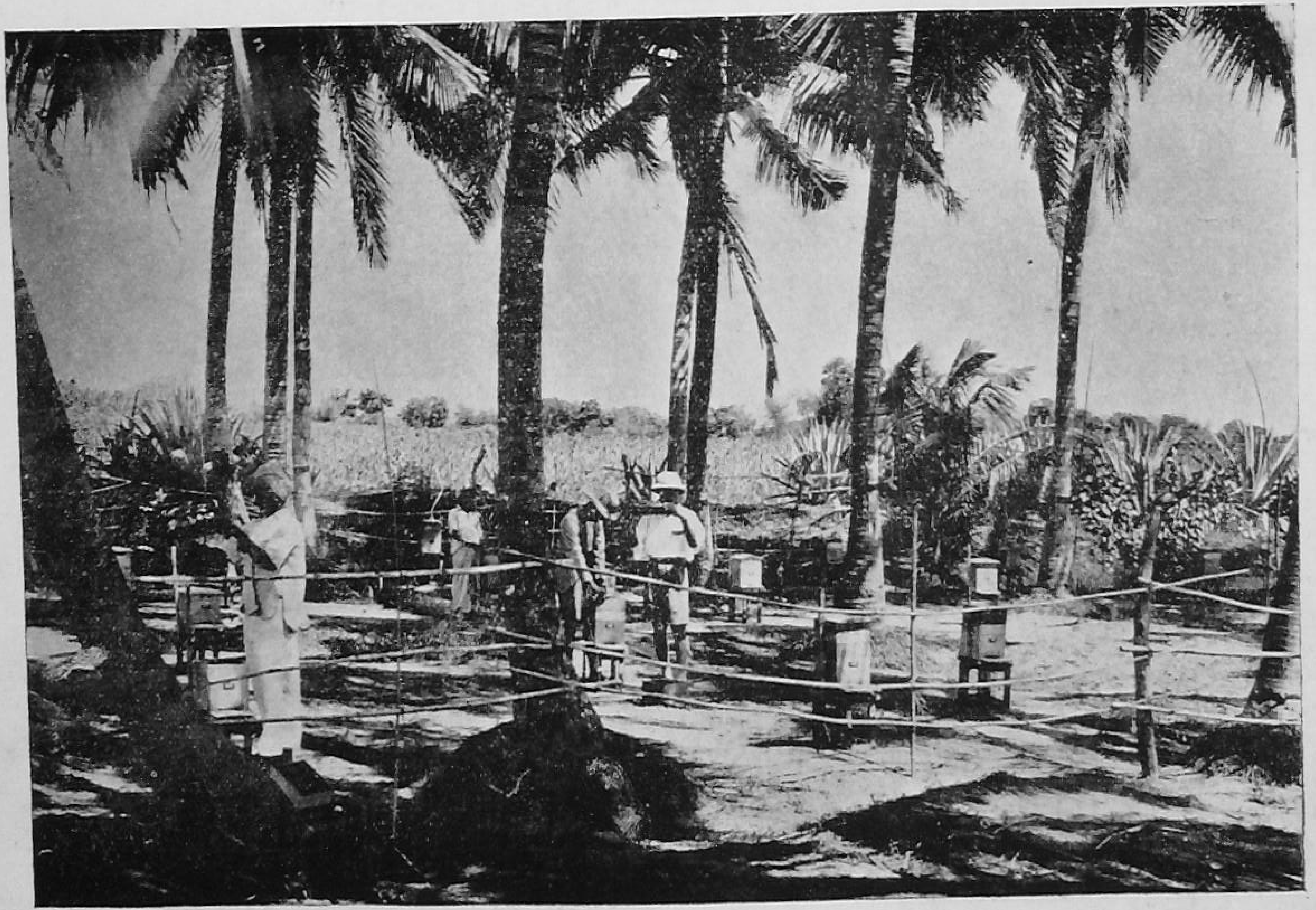

FIG. 29.—AN APIARY OF A. INDICA

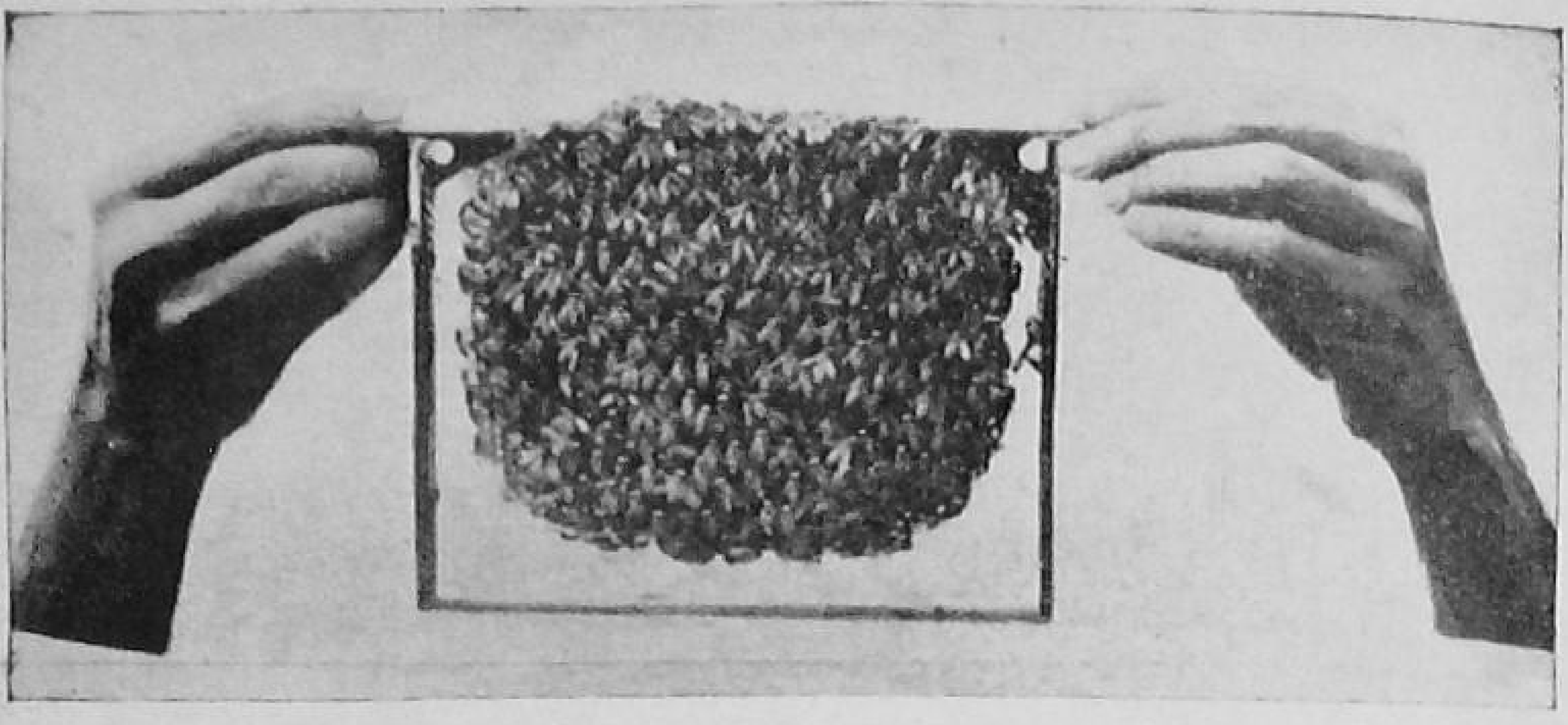

FIG. 30.—EXAMINING COMBS—POSITION 1

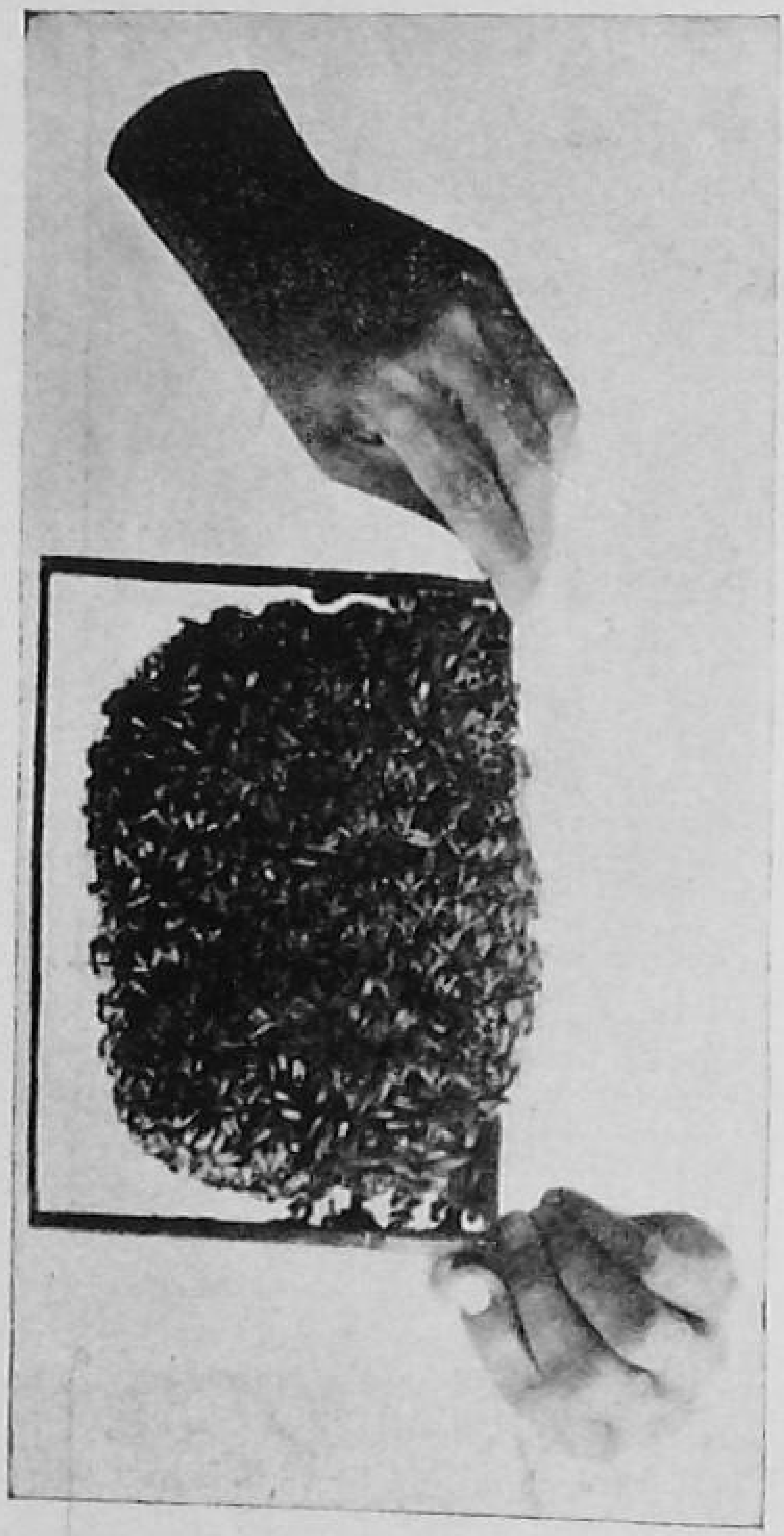

FIG. 31.—EXAMINING COMBS—POSITION 2

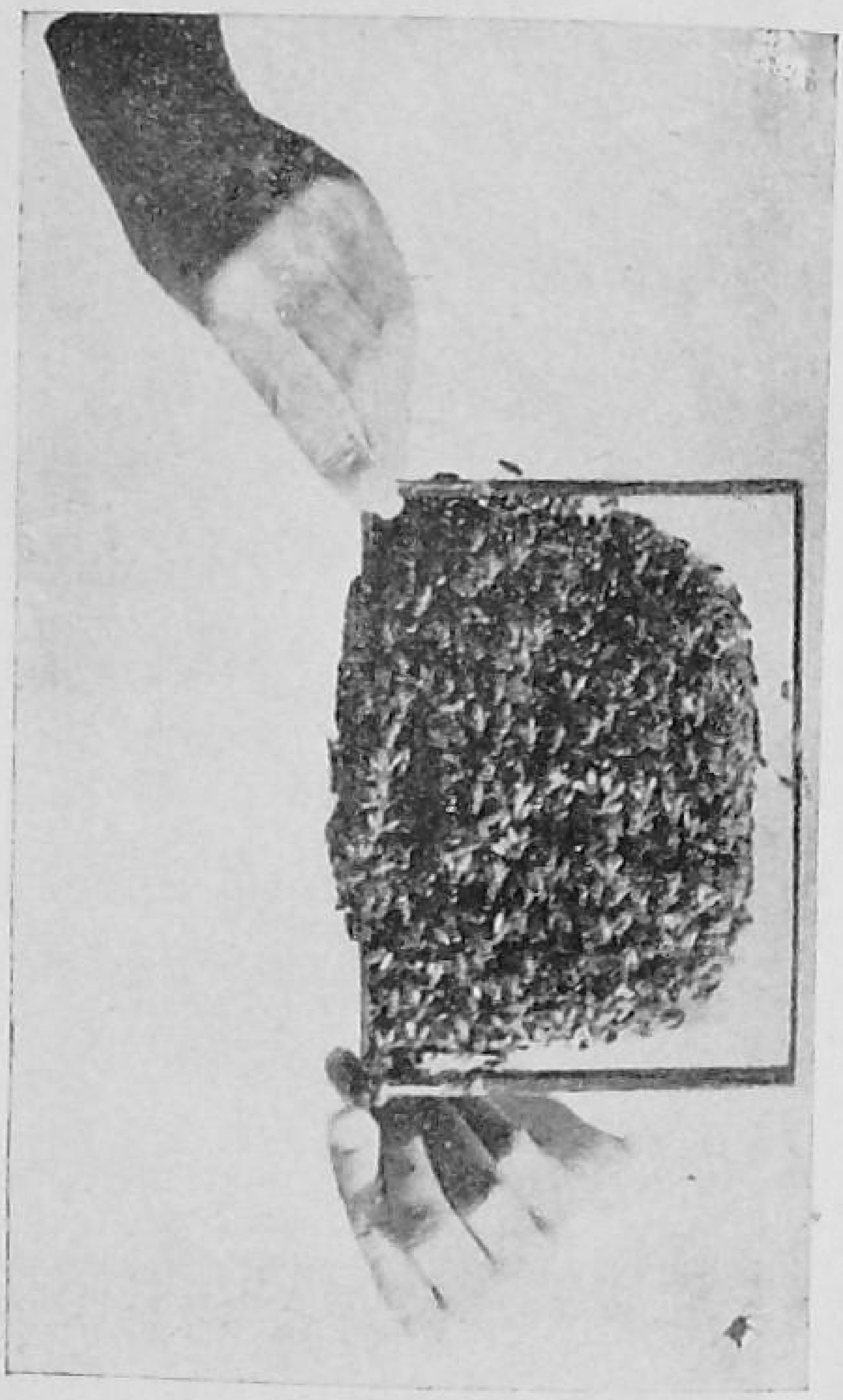

FIG. 32.—EXAMINING COMBS—POSITION 3

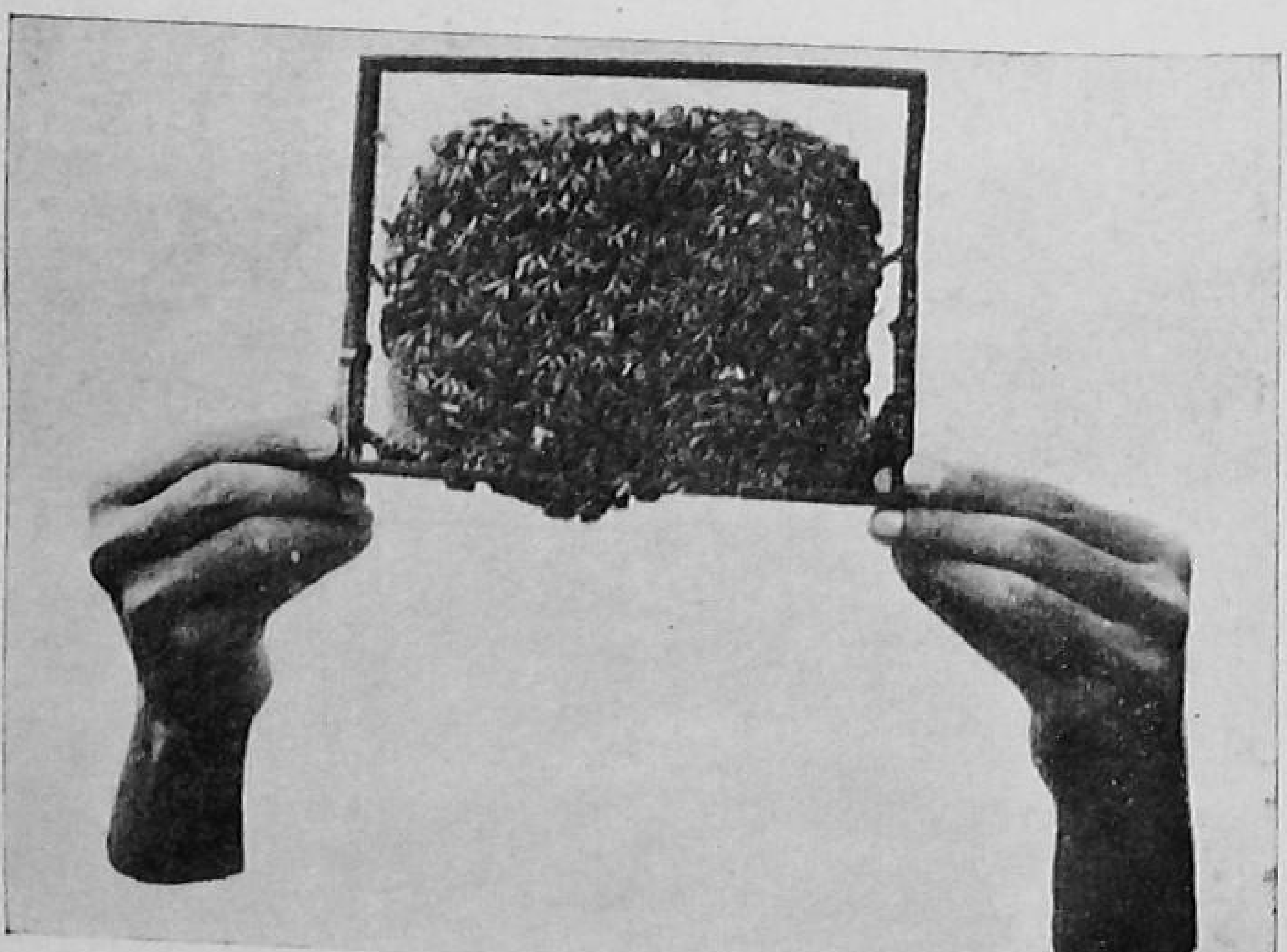

FIG. 33.—EXAMINING COMBS—POSITION 4

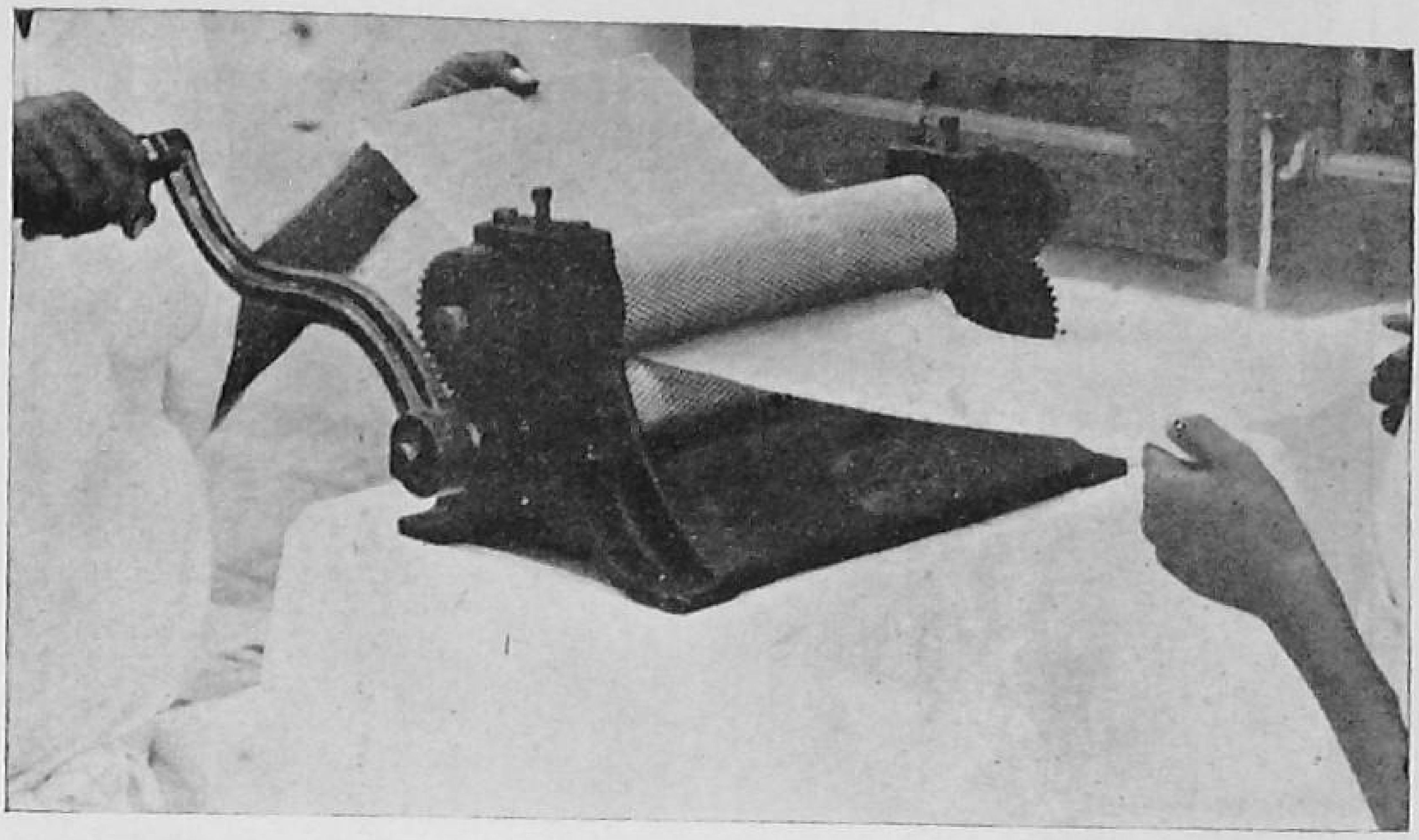

FIG. 34.—COMB FOUNDATION MILL

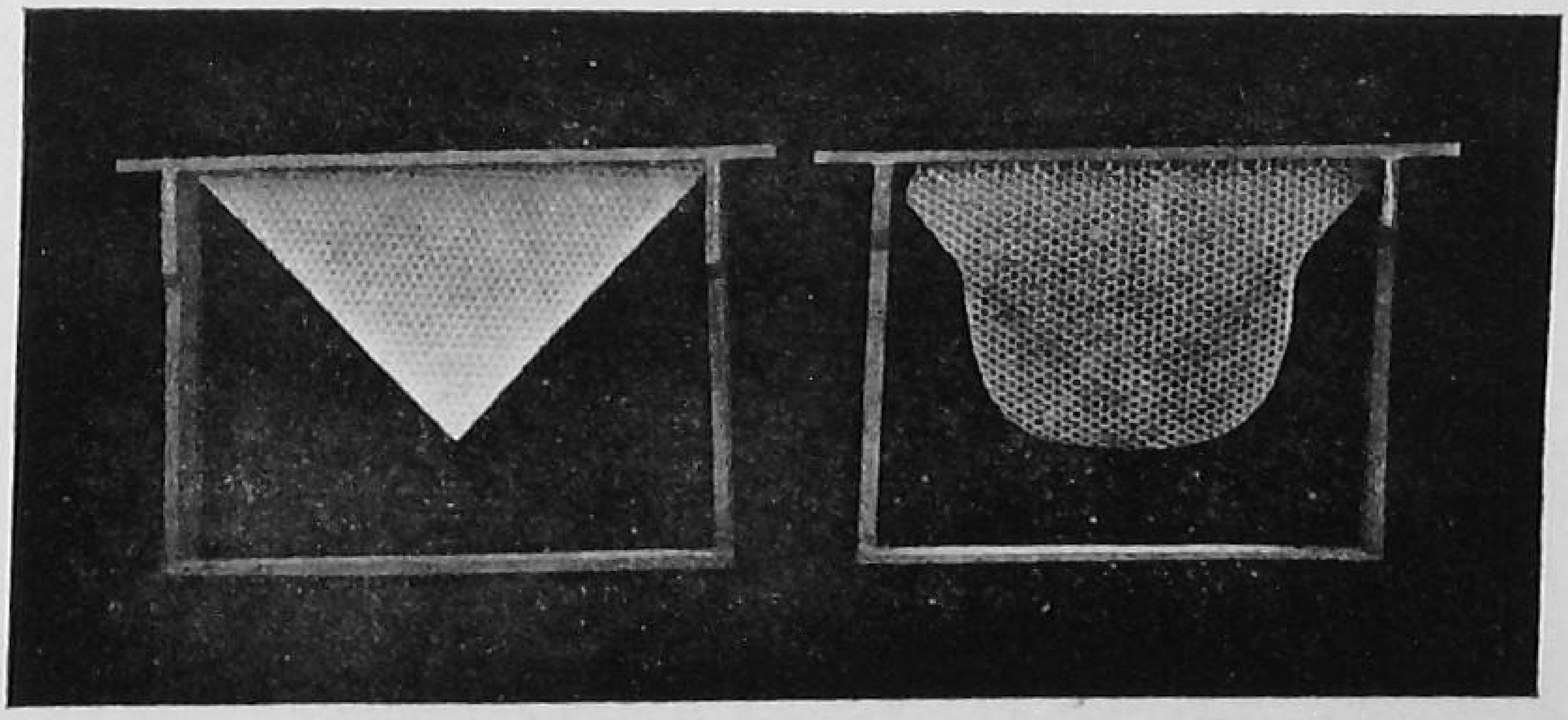

FIG. 35.—COMB FOUNDATION FIXED TO FRAME—FRESH AND DRAWN.

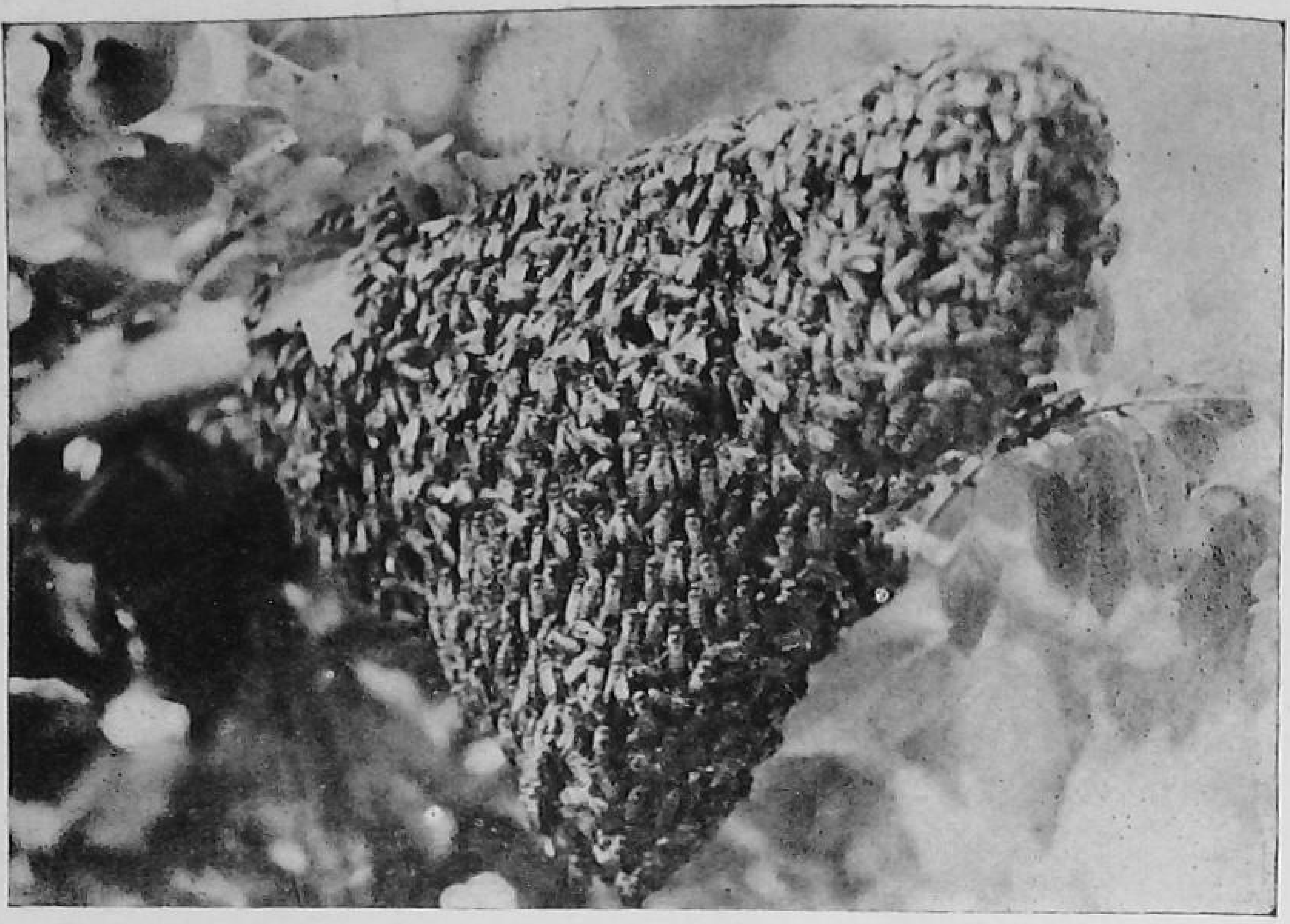

FIG. 36.—A SWARM OF BEES

FIG. 37.—SUPERSEDURE QUEEN CELL

FIG. 38.—HIVING A SWARM

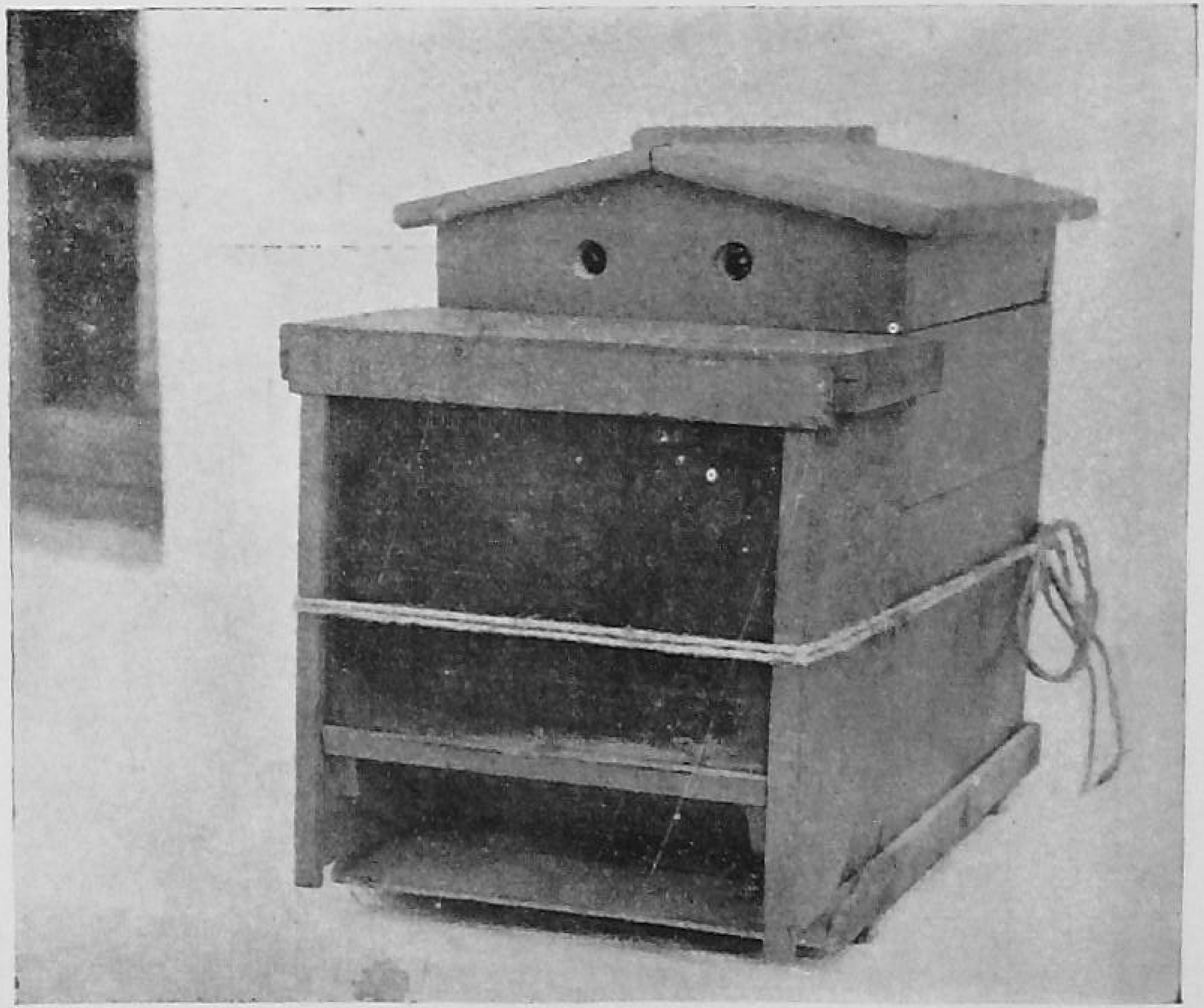

FIG. 39.—SWARM-TRAP

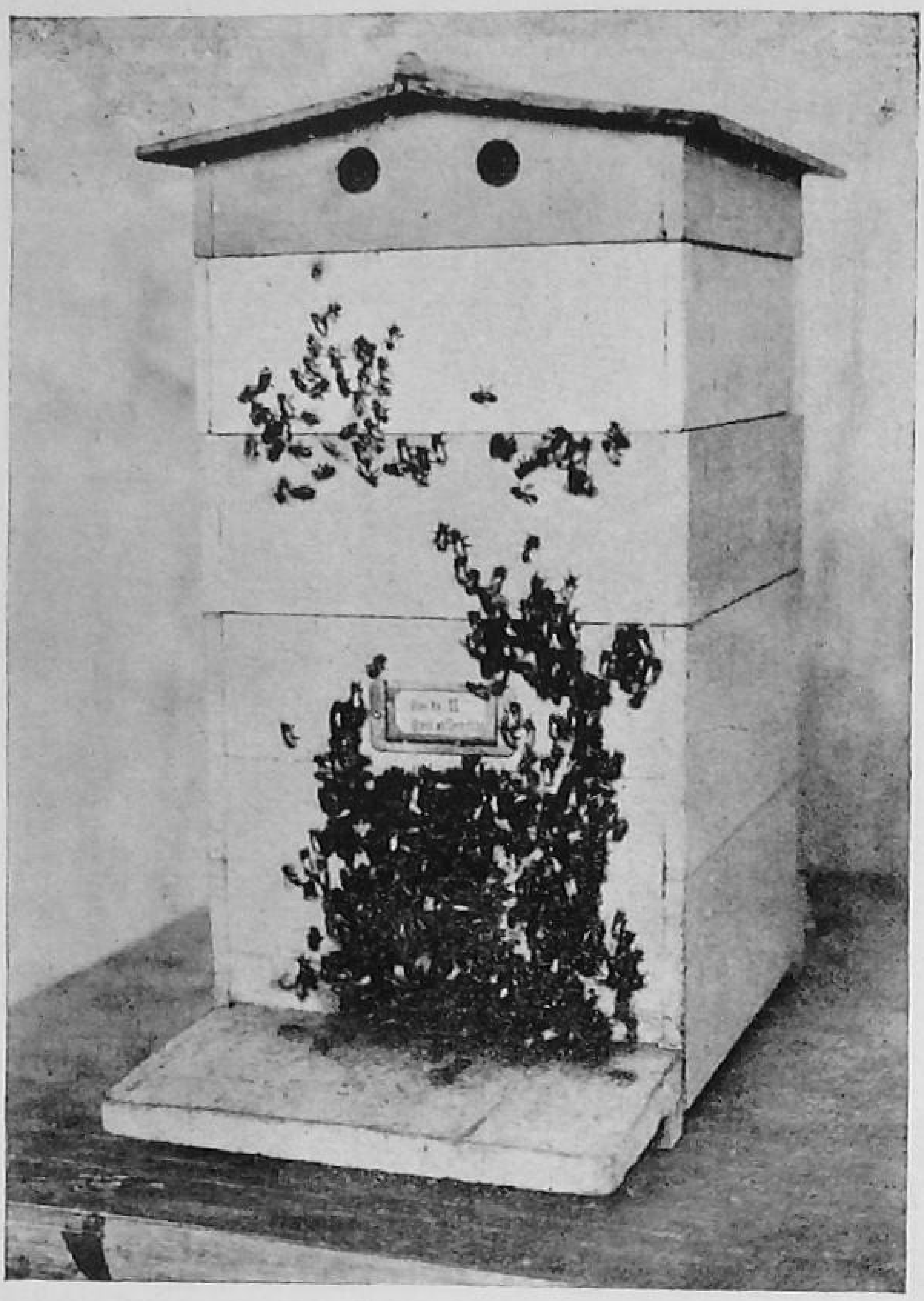

FIG. 40.—A QUEENLESS COLONY

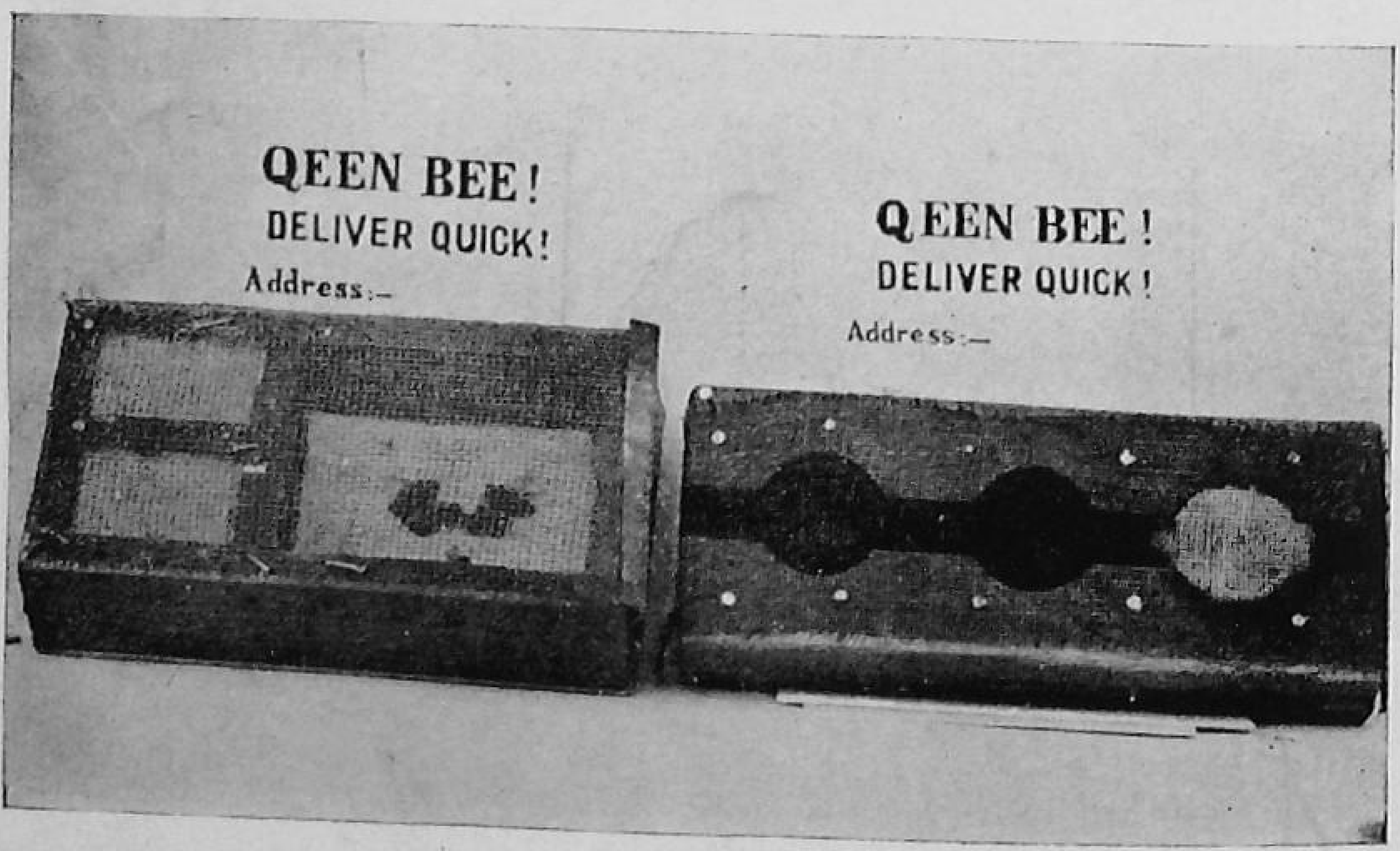

FIG. 41.—QUEEN BEE CAGES

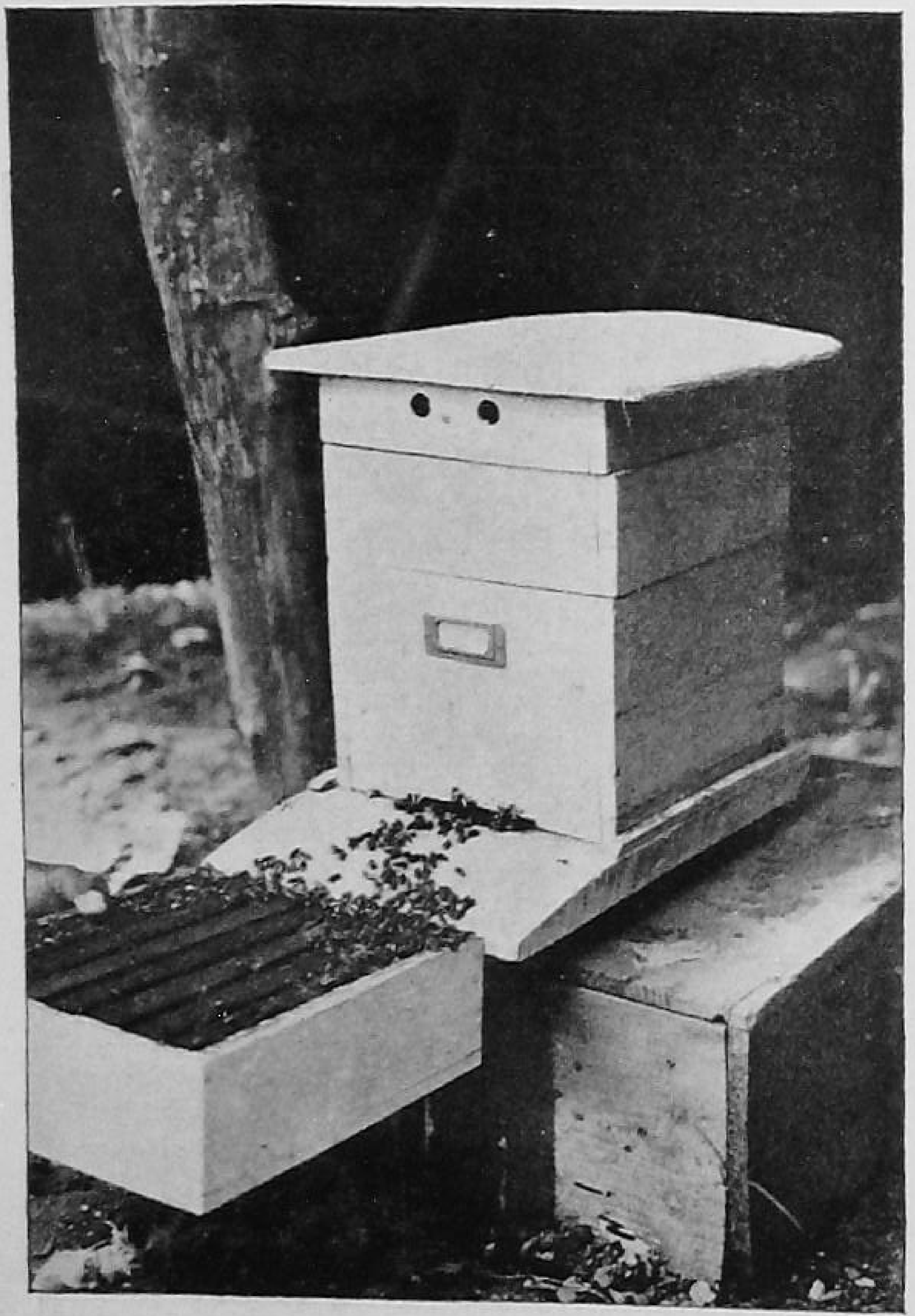
FIG. 42.—DRIVING OFF BEES BY SMOKE

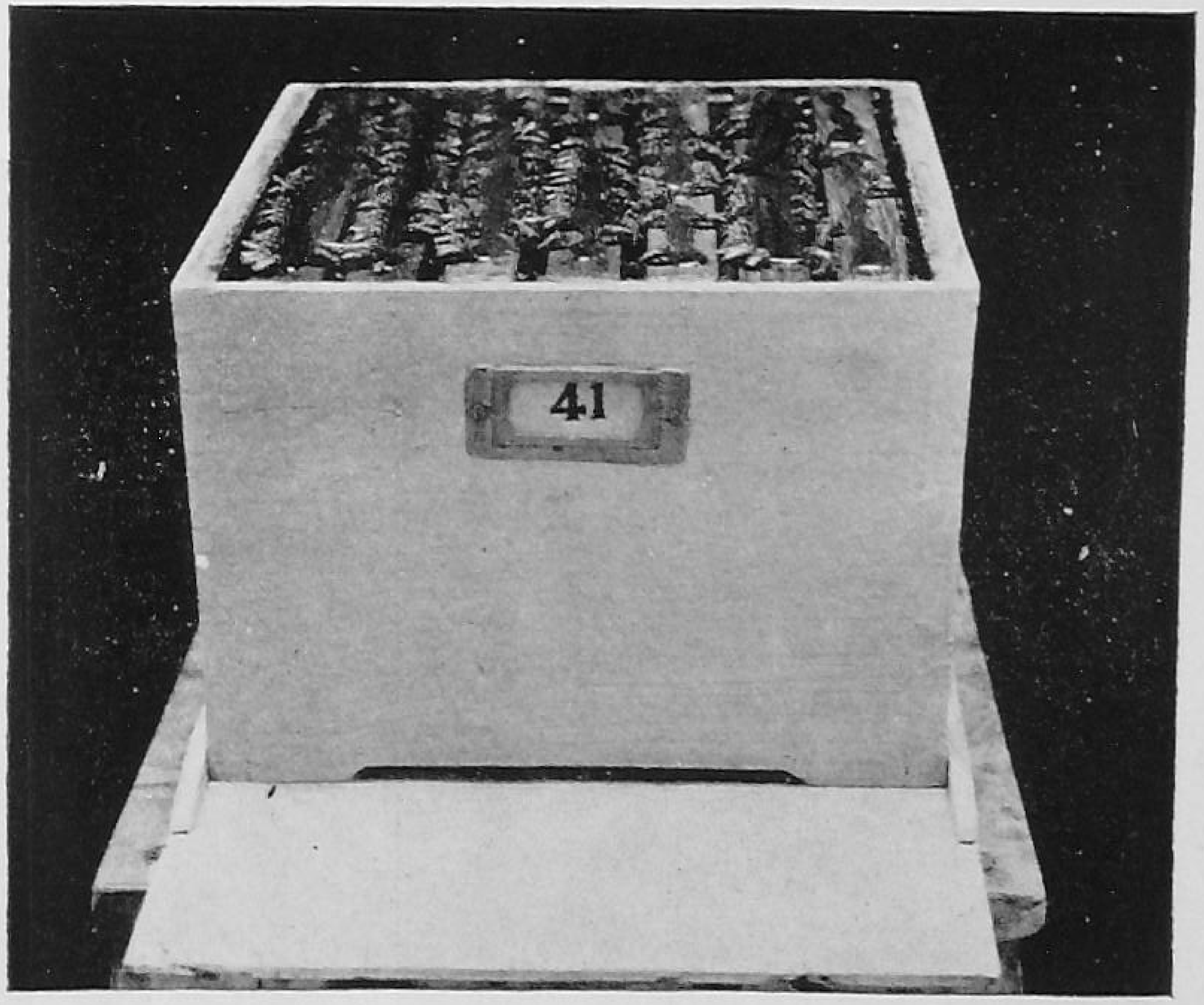

FIG. 43.—ARTIFICIAL FEEDING

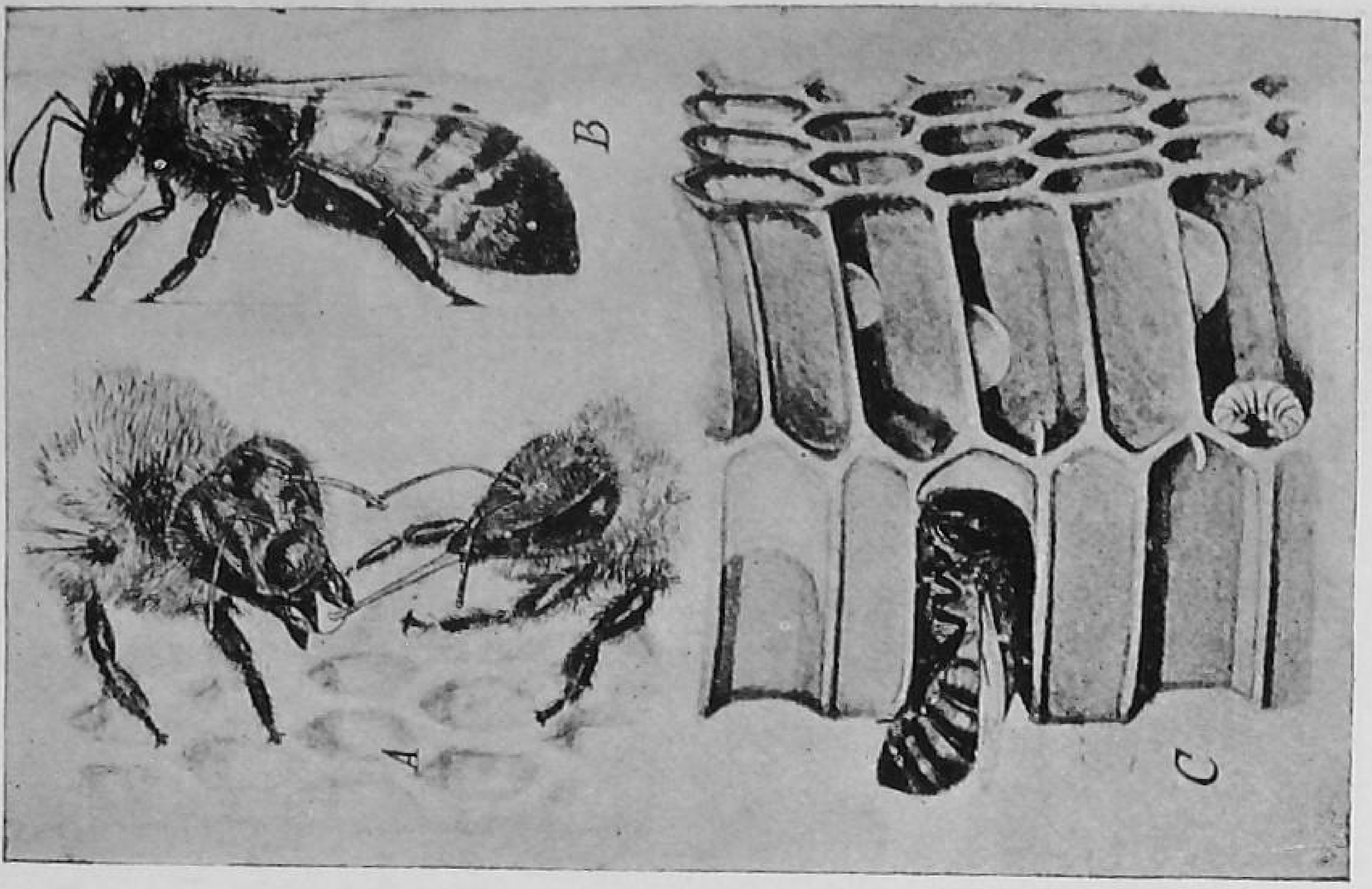

FIG. 44.

A. Nectar being transferred from a loaded nectar-carrier (upper) to a house-bee (lower).
B. House bee ripening honey.
C. House bee depositing honey.

(*Reprint from Journal of Economic Entomology, Vol.* 18, *April* 1925, *Page* 408—*The Storing and Ripening of Honey by Honey-Bees*—*W. Park.*)

FIG. 45.—PORTER BEE-ESCAPE

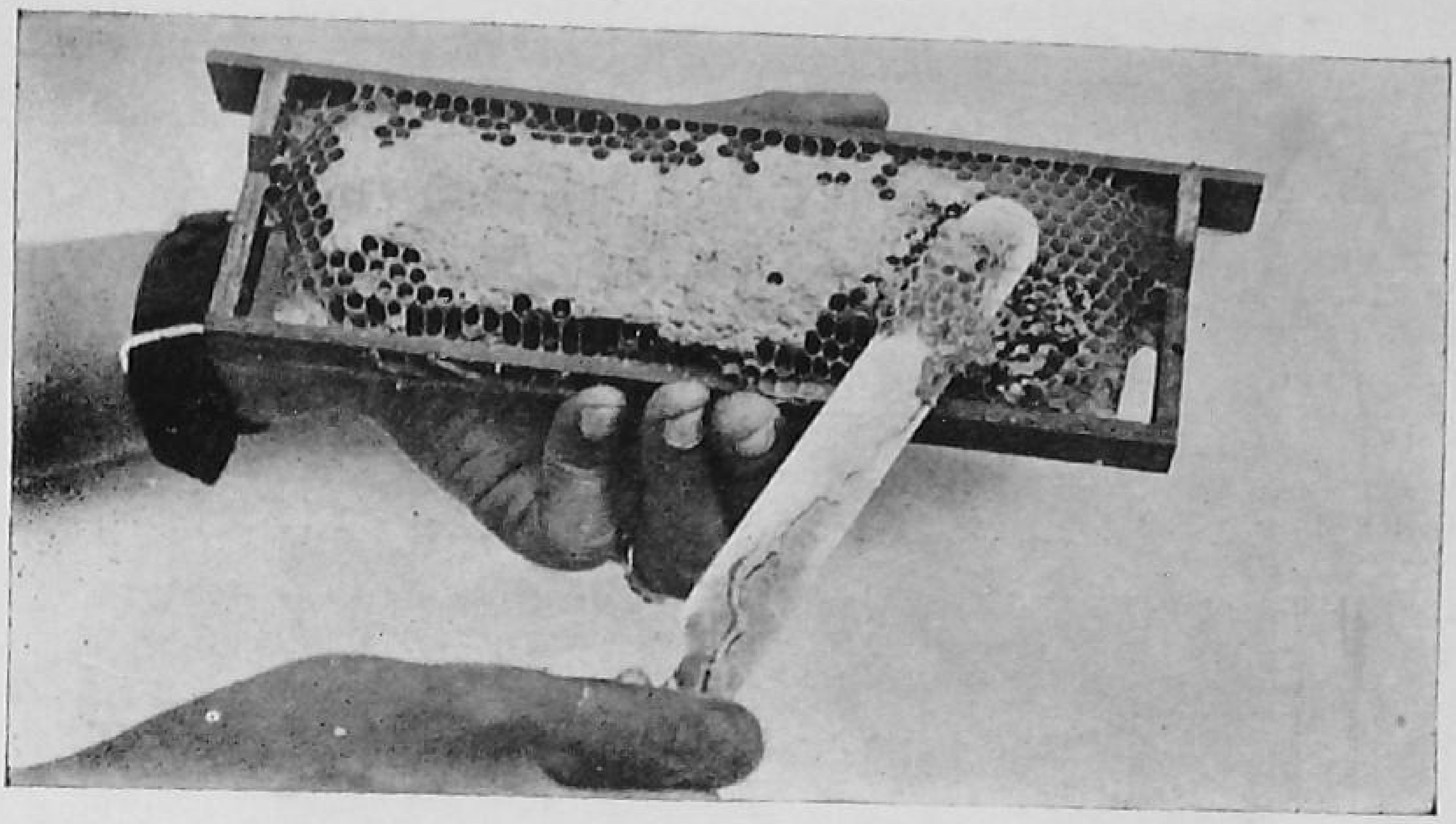

FIG. 46.—UNCAPPING A WELL-SEALED HONEY-COMB

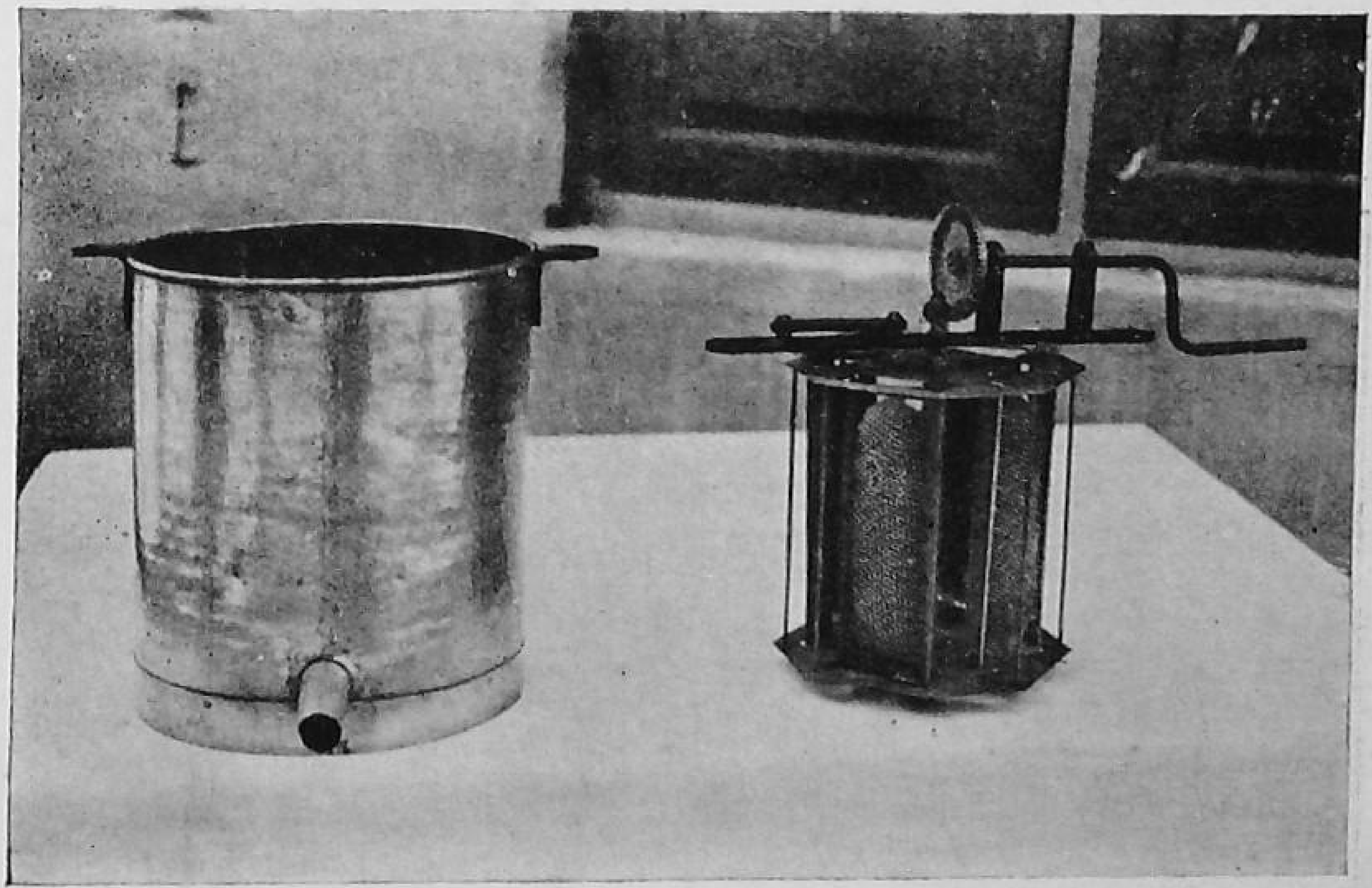

FIG. 47.—HONEY-EXTRACTOR AND ITS PARTS

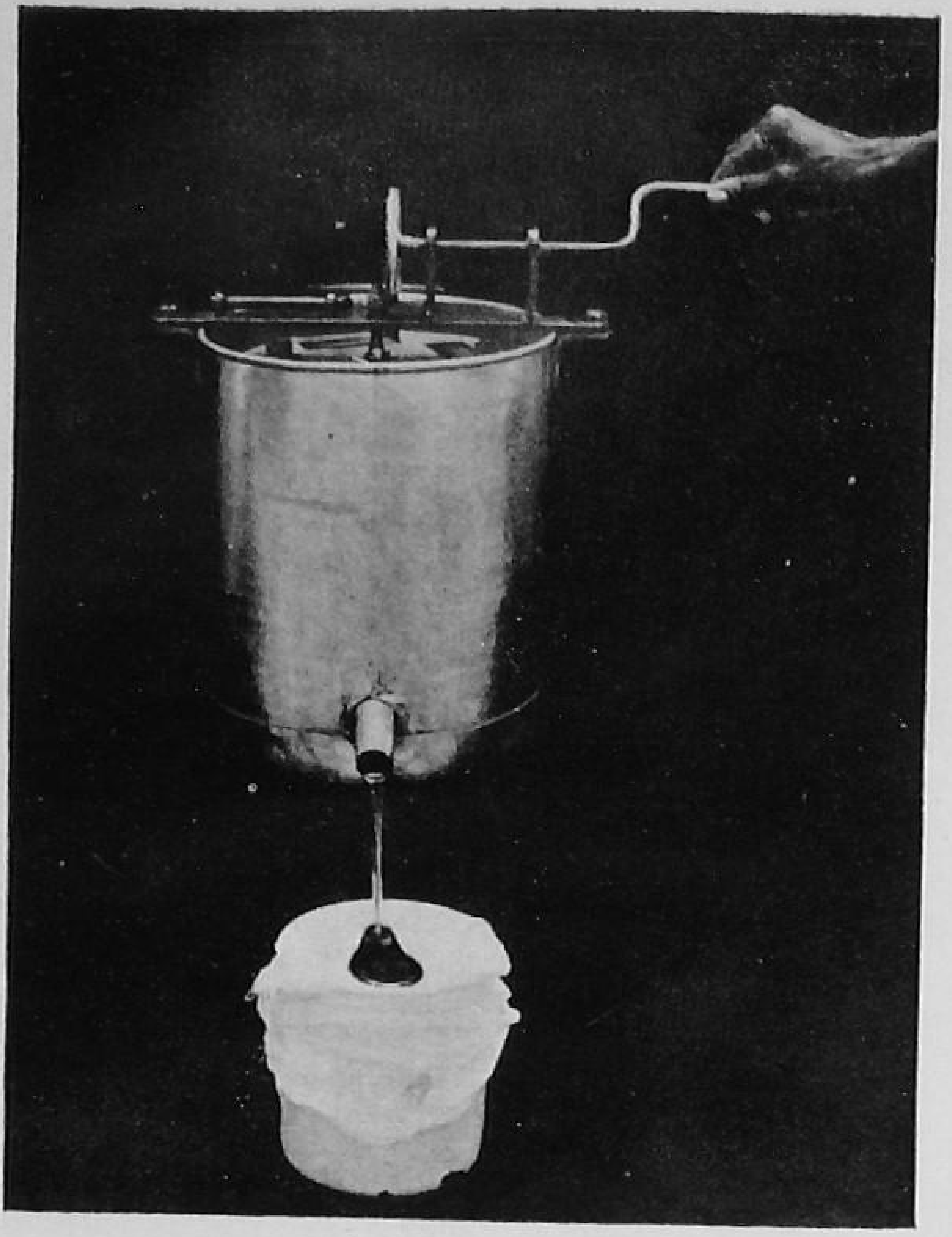

FIG. 48.—HONEY-EXTRACTOR AT WORK

(1) (2)

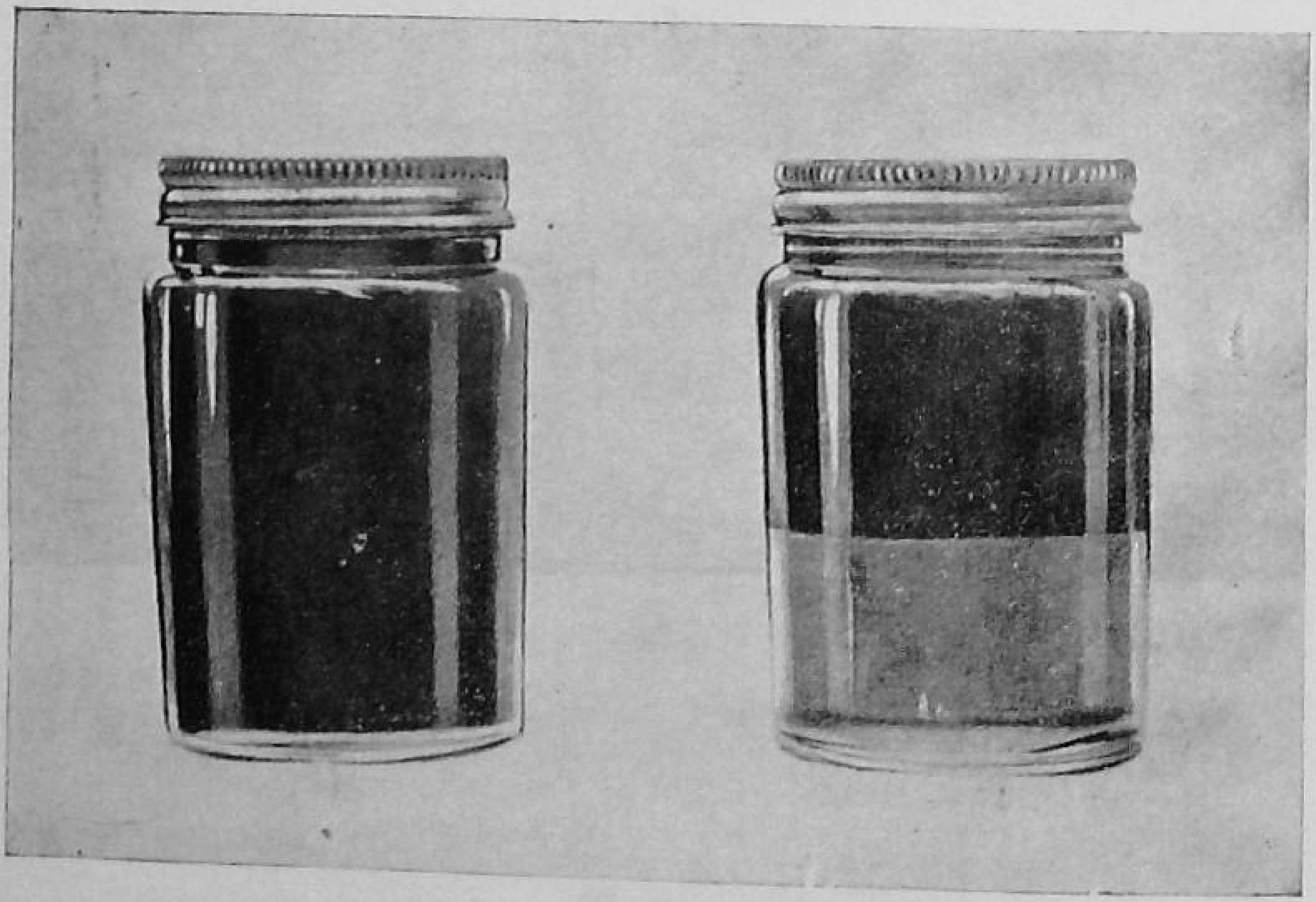

FIG. 49.

(1) Ordinary honey. (2) Granulated honey.

FIG. 50.—HONEY-STRAINER

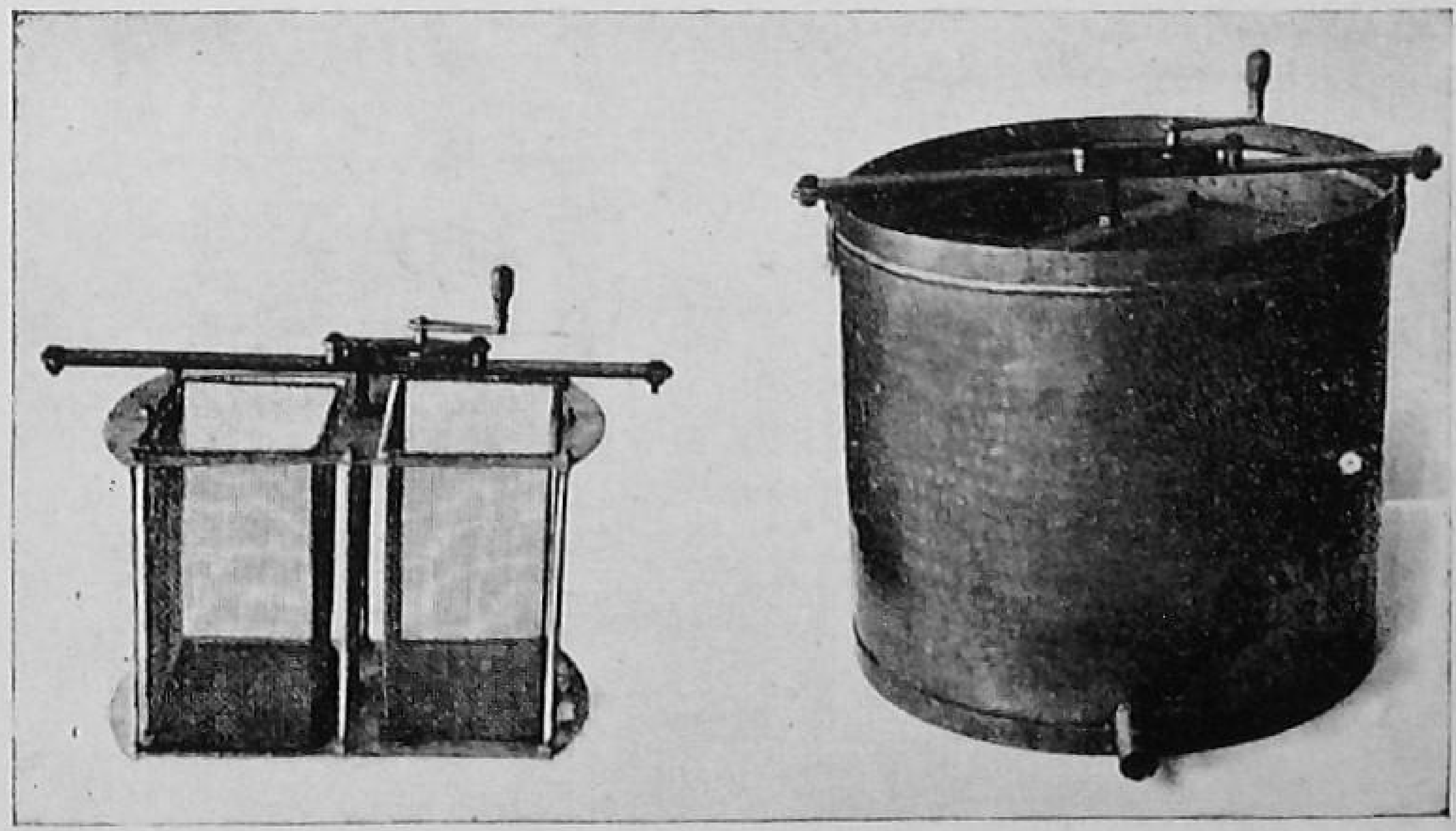

FIG. 51.—ROCK BEE HONEY-EXTRACTOR

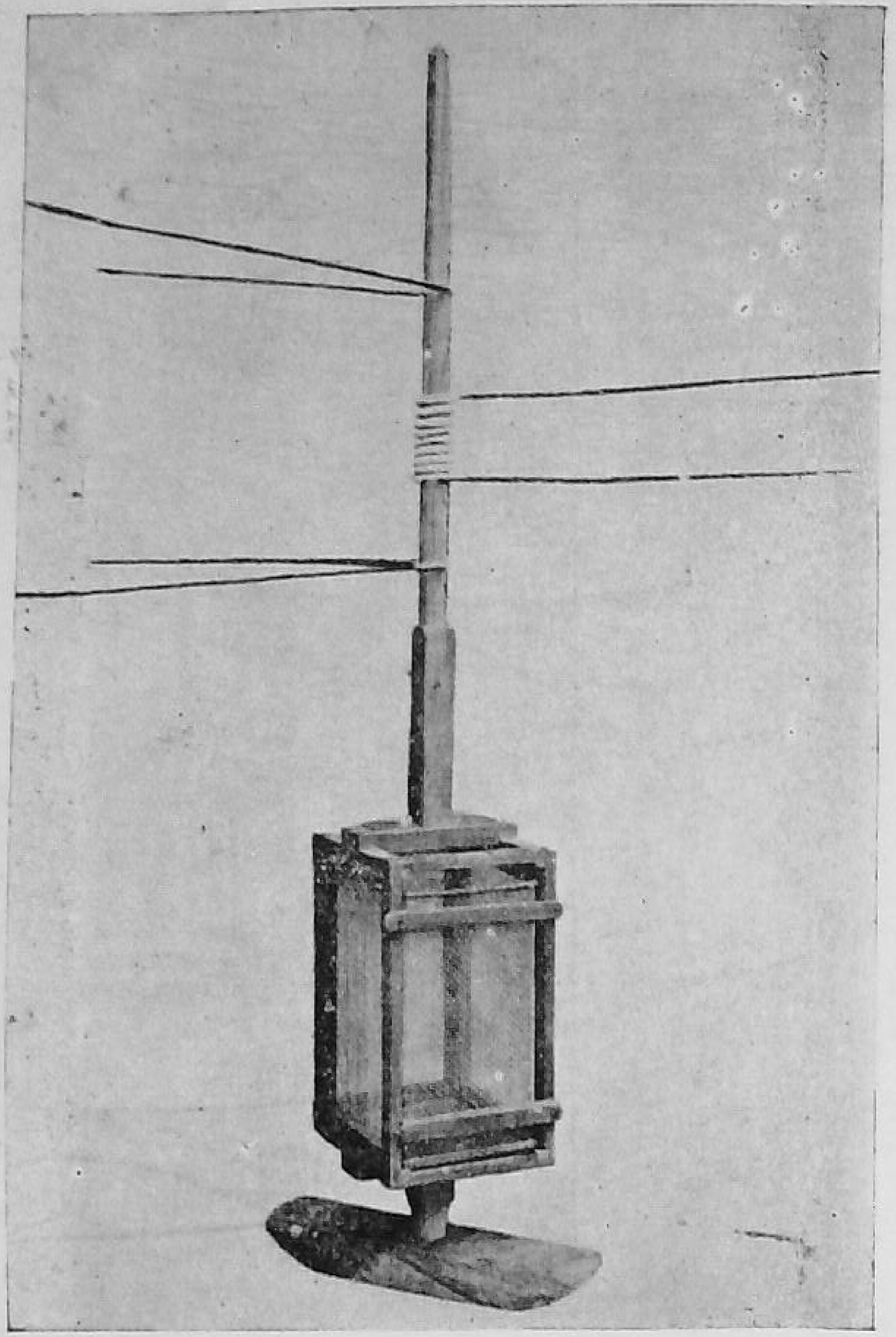

FIG. 52.—CHURN-STAFF HONEY-EXTRACTOR

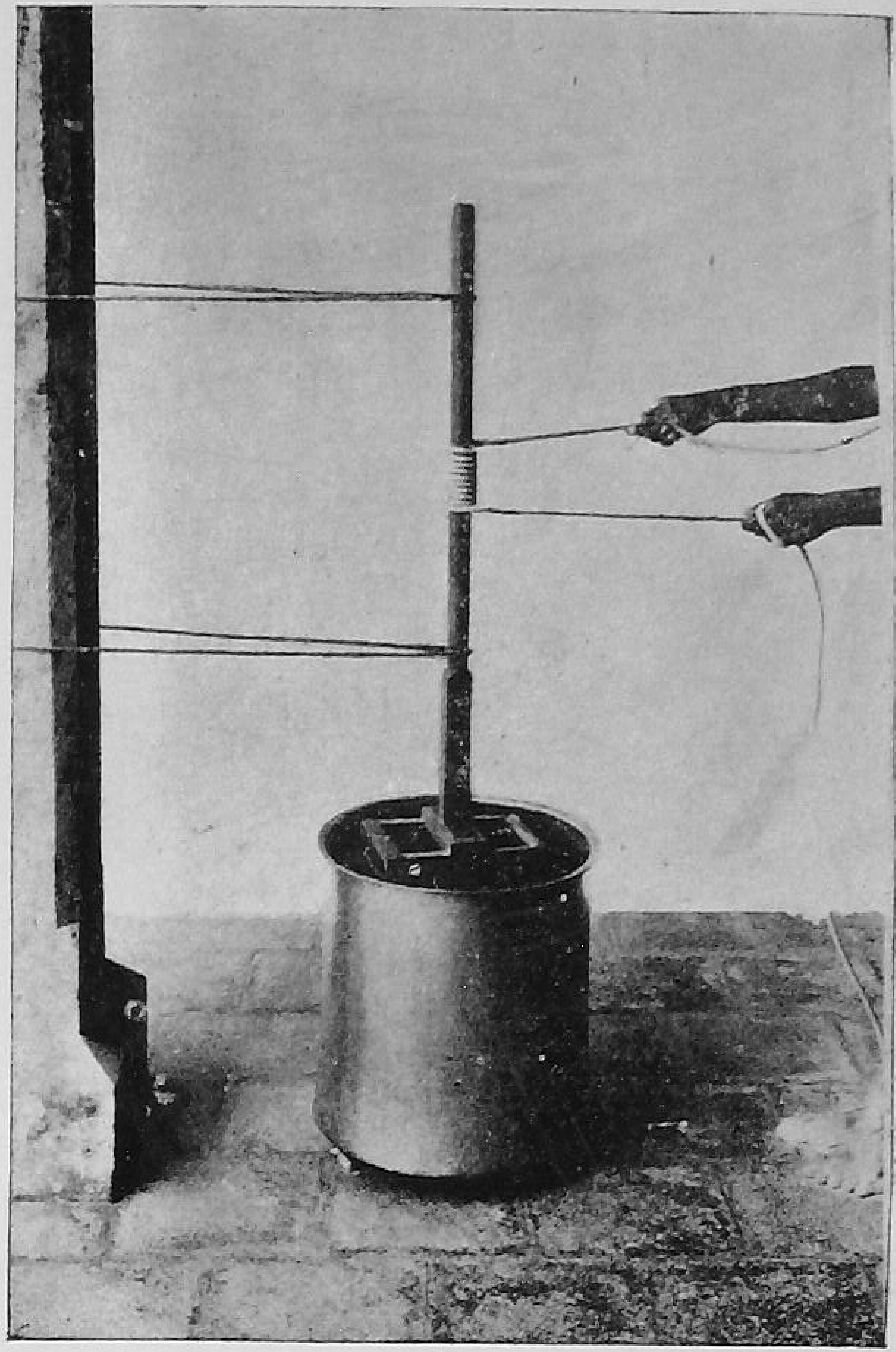

FIG. 53.—CHURN-STAFF HONEY-EXTRACTOR AT WORK

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THE DECCAN PUBLISHING HOUSE, Kozhikode, Malabar district.
A. VENKATASUBBAN, Vellore, North Arcot district.
TIMES MODERN MART, Salem.
K. BHOJA RAO & Co., Mangalore, South Kanara district.
U. R. SHENOY & SONS, Mangalore, South Kanara district.
SRINIVAS & Co., Kumbakonam, Tanjore district.
P. N. SWAMINATHA SIVAN, Pudukkottai, Tiruchirappalli district.
S. KRISHNASWAMI & Co., Tiruchirappalli, Tiruchirappalli district.
V. S. VASAN & Co., Tirunelveli, Tirunelveli district.

IN OTHER STATES.

BANVARILAL JAIN, Agra.
BENARES BOOK CORPORATION, P.O. Lanka, Benares.
NEW BOOK COMPANY, Bombay.
D. B. TARAPOREWALA SONS & Co., Bombay.
THACKER & Co., LTD., Bombay.
N. S. WAGLE, Girgaun, Bombay.
THE POPULAR BOOK DEPOT, Lamington Road, Bombay-7.
THE BOOK COMPANY, Calcutta.
LAW BOOK SOCIETY, Calcutta.
THACKER SPINK & Co., Calcutta.
R. CAMBRAY & Co., Calcutta.
HYDERABAD BOOK DEPOT, Hyderabad.
OSMANIA UNIVERSITY STUDENTS' CO-OPERATIVE BOOK DEPOT, Lallaguda P.O., Hyderabad (Deccan).
S. M. JAGANNATHAM, Nagercoil.
BHAWNANI & SONS, New Delhi.
JAIN BOOK AGENCY, New Delhi.
INTERNATIONAL BOOK SERVICE, Poona.
INTERNATIONAL BOOK HOUSE, Trivandrum.

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